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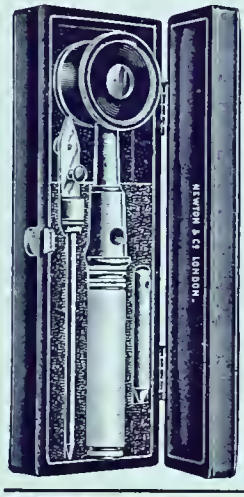

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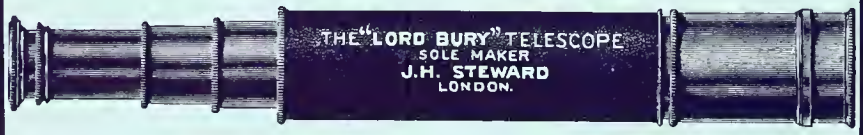

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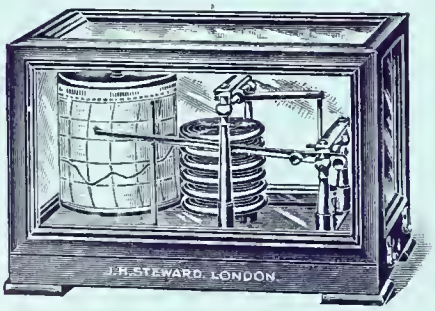

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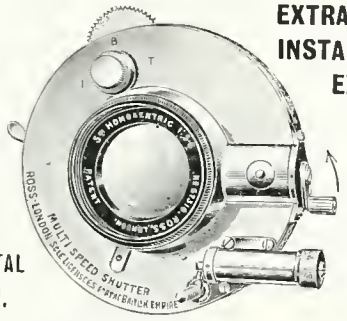

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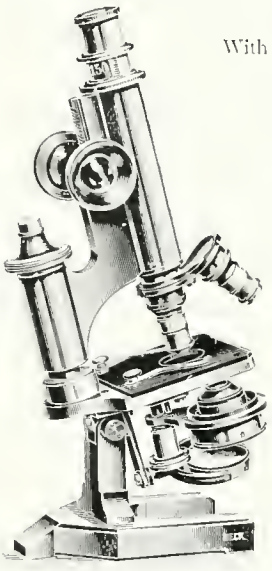

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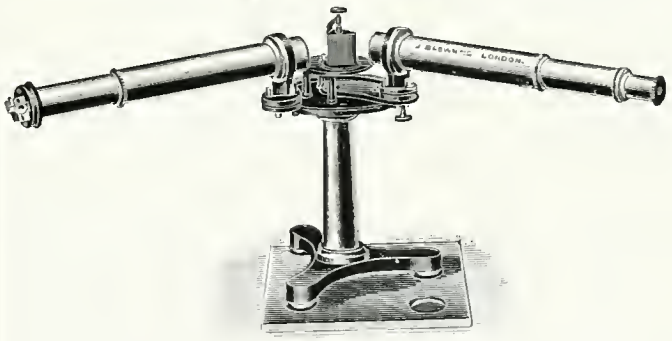

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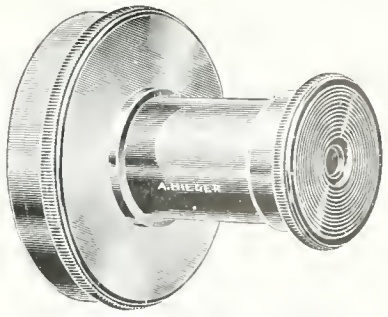
ACTUAL  SIZE.

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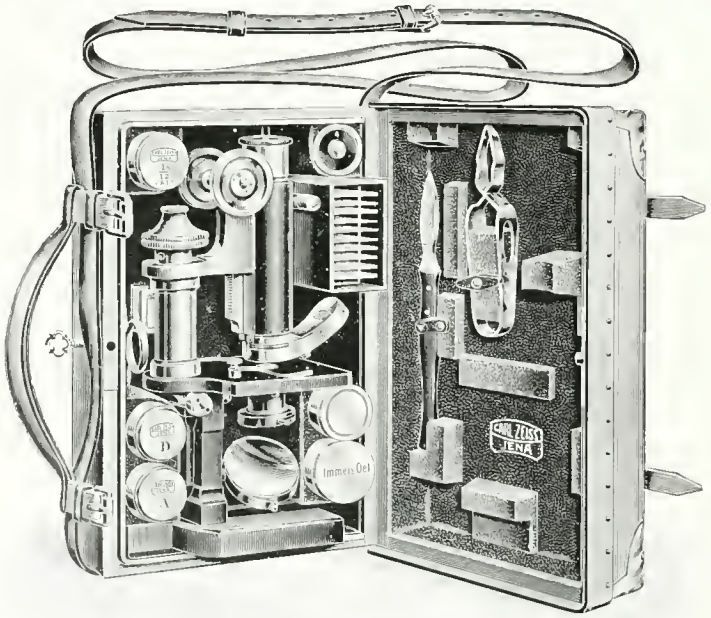

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ON THE STUDY OF DOUBLE STARS BY AMATEUR OBSERVERS. III.

By G. F. CHAMBERS, F.R.A.S.

THE LABOURS OF THE STRUVES.

It may be desirable to give some particulars of the labours of at any rate the two first of the three generations of Struve associated with Double Stars.

The system adopted by the first and greatest of the Struves (F.G.W.S.) was to divide all the Double Stars measured by him into eight classes (and each class into two sub-classes), according to the angular distance of the components. The eight principal classes were as follows:—

Class.				Distance of Components.
I.	...	...	...	Less than 1″
II.	...	...	...	Between 1– 2
III.	...	...	...	,, 2– 4
IV.	...	...	...	,, 4– 8
V.	...	...	...	,, 8–12
VI.	...	...	...	,, 12–16
VII.	...	...	...	,, 16–24
VIII.	...	...	...	,, 24–32

The arrangement of the sub-classes had regard to the magnitude of the Component Stars. The first sub-class of every principal class consisted of conspicuous doubles, termed by Struve *duplices lucidae*; the second of less important doubles termed *duplices reliquae*. The former section comprised stars, each component of which exceeded in brightness the $8\frac{1}{4}$ magnitude: the latter, stars between the magnitudes $8\frac{1}{4}$ and 12—which last was assumed to be the smallest visible in the telescope employed by him, the refractor at the Dorpat Observatory in Russia of fifteen English inches aperture. Struve's system was arbitrary and inconvenient for many reasons. Amongst others, because Double Stars which are Binaries (and there are many such) frequently pass from one Struve class to another in the course of a few years. And a scale of magnitude such as 1—12 took no account of the possibility of bigger telescopes coming into use, nor of the fact that such a scale was altogether out of touch with the common scale made familiar by the labours of the Herschels and many other astronomers long before Struve's time. As a matter of fact the Struve Classification has never been followed by anybody: and the Struve Scale of Magnitudes only to a limited extent. References to Struve's Catalogue are always, and to himself personally often, indicated by the Greek Σ; whilst stars catalogued by his son, Otto Struve, are frequently indicated by OΣ, and sometimes by σ. His grandson Hermann goes as HΣ.

Struve's Main Dorpat Catalogue had three appendices. Appendix I. was made up of sixty stars between 32″ and 7′ in their distances. Appendix II. comprised seventeen stars selected from Appendix I. which were, therefore, more than 32″ apart, but some of which were possessed of decided proper motion. Appendix III. was supplementary, containing later measures of many of the more remarkable stars in the Catalogue.

On the next page is a table, modernised from one published by Sir J. Herschel, which serves the two-fold purpose of indicating how Struve's system appears in print, and of furnishing a series of tests for trying the efficiency of telescopes. This latter was the motive which inspired Herschel to prepare the table, but I recollect once having a conversation with Dawes respecting this table, when he told me that he attached no great importance to lists of the sort so far as regards the *testing* of telescopes. I think, however, that such a list is really of some use, at any rate to an amateur, and therefore I have decided to give it, after having brought it up to date.

0″ to 1″.	R.A. h. m.	Mags.
λ Cassiop...	0 26	6 –6½
36 Androm.	0 49	6 –7
66 Piscium	0 49	6 –7½
γ^2 Androm.	1 57	5 –6¼
52 Arietis...	2 59	6½–7
32 Orionis	5 25	5 –7
ω Leonis ...	9 23	6½–7½
ψ Ursae ...	9 45	4½–6
42 Comae	13 5	5 –5
ξ Boötis ...	14 36	3½–4½
π Lupi ...	14 58	4½–4¾
η Coronae B	15 19	4 –6
γ Lupi ...	15 28	3¾–4
γ Coronae B	15 38	4 –7½
ξ Scorpii ...	15 58	4½ 5
φ Draconis	18 22	5 –7
χ Aquilae...	19 37	6¼–7½
λ Cygni ...	20 43	5 6
4 Aquarii ...	20 46	6 –8
π Cephei ...	23 4	4½–7½

1″ to 2″.	R.A. h. m.	Mags.
ε Arietis ...	2 53	5 –6½
2 Camelop.	4 32	5½–7½
52 Orionis...	5 42	6 –6½
ξ Cancri AB	8 6	6 –7
ι^2 Cancri ...	8 48	5½–7½
ε Chamael...	11 54	5½–6½
γ Centauri	12 36	4 –4
γ Circini ...	15 15	5 –5¼
λ Ophiuchi	16 25	4 –6
ζ Herculis ...	16 37	3 –7
τ Ophiuchi	17 57	5 –6
γ Cor. Aust.	18 59	5 –5
δ Cygni ...	19 41	3½–9
π Aquilae ...	19 43	6 –7

2″ to 4″.	R.A. h. m.	Mags.
α Piscium ...	1 56	3 –4
ε Trianguli	1 57	5½–12
ι Trianguli	2 6	5½–7
γ Ceti ...	2 8	3 –7
12 Eridani	3 7	3½–8
κ Leporis ...	5 8	5 –9
ζ Orionis ...	5 35	2 –6½
μ Canis Maj.	6 51	5½–9
ε Hydrae ...	8 41	4 –7½
γ Leonis ...	10 14	2 –4
ξ Ursae Maj.	11 12	4 –5
ι Leonis ...	11 18	4 –7½
β Hydrae ...	11 47	5 –5
ε Boötis ...	14 40	3 –7
δ Serpentis	15 30	3 –5
μ Draconis	17 3	5 –5¼
ρ Herculis ...	17 20	4½–5¼
70 Ophiuchi	18 0	4 –7
ε Draconis...	19 48	4 –9
ρ Capricorni	20 23	5 –7
μ Cygni ...	21 39	4½–6
ζ Aquarii ...	22 23	4½–4¾
σ Cassiop ...	23 53	5 –7

4″ to 8″.	R.A. h. m.	Mags.
η Cassiop	0 43	4 –7½
ι Cassiop ...	2 20	4½–7
f Eridani ...	3 44	5 –5½
32 Eridani	3 49	5 –6½
μ Eridani...	4 40	4½–0
ω Aurigae	4 52	4 –8
λ Orionis ...	5 29	4 –6
δ Geminor.	7 14	3½–9
α Geminor.	7 28	3 –3½
υ Argûs ...	9 44	3¼–7
α Crucis ...	12 21	1½–2
γ Virginis	12 36	3½–3½
π Boötis ...	14 36	3½–6
ξ Boötis ...	14 46	3½–6½
44 Boötis...	15 0	5 –6
ζ Coronae B	15 35	5 –6
σ Coronae B	16 10	6 –6½
α Herculis	17 10	3¼–6
95 Herculis	17 57	4½–6
κ Cephei ...	20 12	4½–8½
ξ Cephei ...	22 0	4½–6½

8″ to 12″.	R.A. h. m.	Mags.
γ Arietis ...	1 48	4½–5
θ Eridani...	2 54	3¼–4½
β Orionis...	5 9	1 –9
ζ Anthae ...	9 26	6 –7
2 Can. Ven.	12 11	6 –9
γ Delphini	20 42	4½–5½

12″ to 16″.	R.A. h. m.	Mags.
8 Monocer.	6 18	4½–7
γ Volantis...	7 9	5 –7
ξ Ursae Maj.	13 19	2¼–4
κ Boötis ...	14 9	5½–8
η Lupi ...	15 53	3¾–8½
β Scorpii AC	15 59	3 –6
δ Herculis	17 10	3¼–8½
β Cephei ...	21 27	3½–8

16″ to 24″.	R.A. h. m.	Mags.
ζ Piscium ...	1 8	5 –8
α Ursae Min.	1 22	2½–9½
χ Tauri ...	4 16	6 –8
24 Comae B	12 30	5½–7
α Can. Ven.	12 51	3 –6½
α Centauri	14 32	1 –2
ε Normae	16 19	5 –7
61 Ophiuchi	17 39	6 –7
41 Draconis	18 7	5½–6
κ Cor. Aust.	18 26	6¼–7
θ^1 Serpentis	18 51	4¼–4½
61^1 Cygni ...	21 2	5½–6

24″ to 32″.	R.A. h. m.	Mags.
23 Orionis	5 17	5 –7
κ^1 Herculis	16 3	5 –7
ψ^1 Draconis	17 43	4½–5¼
η Lyrae ...	19 10	4½–9
χ Cygni ...	19 42	5 –9

β Leporis.

Mags. 3, 11: Distance 3″.

θ Orionis. (Scale 25″ to 1 inch).

Mags. 6, 7, 7½, 8, 10½, 11.

15 Monocerotis.

Mags. 6, 9½, 11: Distances 3″, 16″.

12 Lyncis.

Mags. 6, 6½, 7½: Distances 1½″, 8″.

Sirius.

Mags. —1½, 10: Distance 9″.

ϵ Canis Majoris.

Mags. 2½, 9: Distance 8″.

116 P. VII. Monocerotis.

Mags. 6, 8, 9, 10, 12.

α Geminorum.

Mags. 3, $3\frac{1}{2}$: Distance 5″.

γ Argûs.

Mags. 2, 6, 8: Distances 41″, 62″.

ξ Cancri.

Mags. 6, 7, $7\frac{1}{2}$: Distances $1\frac{1}{4}$, 5″ (1905).

λ Velorum.

Mags. 6, 9, 10: Distances 4, 20″.

γ Leonis.

Mags. 2, 4: Distance 4″.

γ Argûs.

Mags. 3, 7½: Distance 2½″.

ξ Ursae Maj.

Mags. 4, 5: Distance 3″ (1909).

α Crucis.

Mags. 1½, 2, 5: Distances 5″, 90″.

γ Virginis.

Mags. 3½, 3½: Distance 6″ (1909).

ξ Ursa Maj.

Mags. 2¼, 4: Distance 14″.

α Centauri.

Mags. 1, 2: Distance 21″.

INNES'S CLASSIFICATION.

In the "Introduction" to his *Reference Catalogue* Innes broaches several topics of interest in connection with Double Stars which have not hitherto been very fully or generally discussed, albeit many of them of real practical importance. He starts with a question which, though it is a very obvious one, has not, I think, hitherto received much notice. "What is a Double Star?" Then he goes on to say:—"Should the wide pairs of the earlier astronomers be indiscriminately included? It is easier to say 'No' to the latter suggestion than to give a definition of what should constitute a Double Star that will meet all views. A compromise has been adopted: in addition to many rather wide pairs, worthy of inclusion from some point of view, every known southern Double Star finds a place here which falls within the limits of distance given in the following table:—

Magnitude of Primary.	Limiting distance of Components.
1	30″
2	25
3	20
4	15
5	10
6	7
7	5
8	3
9	1

"These limits do not exclude any Binary pair in either hemisphere. Some systems, much exceeding the above distances and showing no certain signs of orbital motion, have been included on account of the large proper motion common to both components."

It must be understood that I am quoting the foregoing as laying down a scheme for the compilation of a Catalogue of Double Stars which is to be based on certain definite principles.

THE NOMENCLATURE AND IDENTIFICATION OF STARS.

On the question of nomenclature Innes has propounded some ideas eminently proper and reasonable for the purposes of a publication issued under official authority, and which ideas are especially marked by fairness towards individual discoverers of Double Stars.

Innes has also discussed a matter of some practical importance but of considerable practical difficulty. The Double Star observer in specifying the magnitudes of the two stars which he has seen will say correctly (or it may very likely be, incorrectly) that they are of magnitudes so and so. The photometric observer and the astronomical map-maker or editor will for his purposes ignore the duplicity of the star, and will record the two stars as one, giving the conjoint magnitude. The problem will be—"What magnitude is to be assigned to the two stars treated jointly as one?" Innes has suggested a formula, and has framed a table by means of the formula, which, though it is somewhat technical and intricate, must receive some notice, however brief, in this paper. The point involved will be best understood by citing two concrete examples which he gives.

(1) The magnitude of the very bright star α Centauri is put as—0·2. "What are the individual magnitudes of A and B?" He suggests that as the difference between the two magnitudes is 1·5, therefore the magnitude of A is—0·4, and of B 1·9, these figures lumped together photometrically combining to make the naked eye magnitude of the Star, regarded as one, to be 0·2.

(2) The inverse case may be represented, say, by taking two stars of equal magnitude, that magnitude being *e.g.* 6·8. The question is "What should be the apparent magnitude of those two stars combined as one?" Innes answers the question by saying that the naked-eye magnitude would be 6·0.

Respecting his formula and table he confesses that though the table (which depends upon the accepted light-ratio of 2·512 to which the *Durchmusterung* magnitudes are supposed to conform), holds good for most pairs, he is convinced that it does not apply to pairs where both components are faint. Partly because of this reservation, and partly because the subject involves minuteness of detail with which I fancy that few amateurs will care to trouble themselves, I do not propose to go further into the matter, and shall content myself by saying that when an observer desires to observe a pair of stars presented to him as a Double (or Triple) Star, he must add something to the specified magnitude of Star A when he goes to the telescope to find the pair. How much he should add will obviously differ in every case: but as a sort of rule of thumb addition he will in most cases, I think, be safe in looking for a star brighter by $\frac{1}{4}$ or $\frac{1}{2}$ a magnitude than the printed magnitude affixed to Star A.

(To be continued.)

THE CHEMISTRY OF INKS IN HANDWRITING.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

THE general principles underlying the chemical methods of distinguishing between different kinds of ink in handwriting have already been described in a former issue of "KNOWLEDGE," (1907, Vol. iv, p. 147), but before giving some account of further applications of chemistry in this direction, I may, perhaps, be allowed briefly to recapitulate the main outlines of the theory, and to add some details by way of illustration.

Ordinary writing ink is essentially a mixture of a decoction of galls with a solution of copperas (ferrous sulphate), which slowly interact to form an iron tannate that gradually becomes oxidised by exposure to the air, and gives the black pigment of handwriting.

Characters written with a pure iron gall ink are nearly colourless when first put upon paper, and a considerable time is needed for the insoluble black tannate to be formed within the fibres.

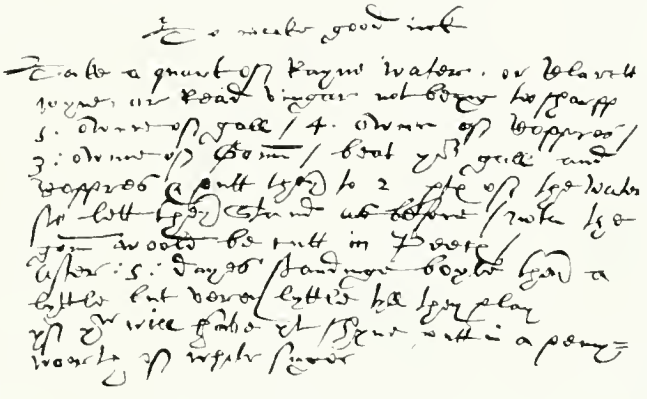


FIGURE 1.

Elizabethan domestic recipe for making ink.

Prior to about the end of the 18th century, inks were exposed to the air or boiled, so that a partial oxidation might take place within the fluid, and thus give some depth of tint to the product before it was used for writing. The chief objections to such partial oxidation are that deposits are formed in the bottle, and prevent the ink flowing smoothly from the pen, and that the fluid has not the penetrating power of an unoxidised ink. Such inks, however, are still on the market, under the name of "Japan inks," but they are but little used, their place having been taken by unoxidised inks, in which the black pigment is, as it were, in a latent condition, and a second pigment, such as indigo, logwood, or an aniline dye-stuff, is added to give a colour to the writing pending the formation of the iron tannate.

The dye-stuffs employed in the commercial inks of to-day vary in colour from pale greenish-blue to indigo and deep violet, and no two give identical reactions—at all events when mixed with iron tannate to form the pigment in writing. It is mainly owing to the differences in these provisional colouring matters that it is possible to distinguish between handwriting written with different kinds of ink.

In the old type of iron gall ink, in which no such second pigment was used, it would only have been possible to distinguish between different makes of ink in handwriting in exceptional cases, such as when a large excess or a great deficiency of iron had been used. Such irregularities in composition might readily occur, however; for in the days before the ink manufacturer could have made a living, writing was a polite accomplishment restricted to those who could afford the time, and the ink was made at home. Each housewife had her recipe for making a good ink, and its preparation was as much within her province as the making of cordials or the baking of bread.

A particularly interesting example of a domestic recipe, which was handed down as an heirloom, is shown in the accompanying figure, which Mr. G. Weddell has kindly allowed to be reproduced.

This was taken from a manuscript collection of old family recipes dating back into the 16th Century, which Mr. Weddell has published in *facsimile* (*Arcana Fairfaxiana Manuscripta*, 1890). Directions are given for making everything needed for household use, from apple pasties to cures for the king's evil, and among its odd assortment of items are included several recipes for making ink, of which the above example, which was probably written towards the close of the 16th century, is typical.

The directions here given are to soak five ounces of galls in one quart of rain water (or claret or red vinegar) and to boil the decoction, after five days' standing, with four ounces of copperas and three ounces of gum.

Ink made under the rule-of-thumb methods of the housewife must inevitably have often varied widely in composition, and it is to such variations from the right proportions of iron to galls that we must attribute the want of permanency of some relatively modern writings, as compared with that upon manuscripts centuries older.

No more interesting illustration of this effect of composition of ink upon the permanency of writing can be found than in the various names written on the first page of Milton's family Bible, to be seen in the British Museum. It will be noticed that all the entries of the births of himself and the members of his family are in the handwriting of Milton, and that, with one exception, all the inks are of a good dark tone. The exception is seen in the entry of the

birth of his daughter Deborah, on "the 2nd of May, being Sunday, somewhat before three of the clock in the morning, 1652." Here the ink has faded to a faint brown colour.

Considerable variations are possible in the proportions of iron to gallotannic acid without changing the nature of the resulting black pigment, but if there is a deficiency of tannin outside those limits, insufficient pigment will be formed, and the excess of iron will cause the writing to turn brown. A lack of tannin to combine with all the iron in the ink is probably the explanation of this faded entry in Milton's Bible.

The actual pigment formed when ink dries seems to be the same whether the proportion of tannin to iron be large or small. The writer has made numerous analyses of the deposits produced when solutions of the two substances of varying strength were allowed to stand in contact with the air, and has found them to contain from 5·4 to 6·2 per cent. of iron.

Of the known insoluble iron tannates the one that best corresponds with this proportion of iron is that described by Wittstein (*Jahresb. der Chem.*, 1848, *28*, 221) and by Schiff (*Ann. Chem. Pharm.*, 1875, *175*, 176) which contains 5·53 per cent. of iron, and has the formula:—

$$\begin{matrix} Fe\ (C_{14}\ H_9\ O_9)_3 \\ | \\ Fe\ (C_{14}\ H_9\ O_9)_3 \end{matrix}$$

It is probably this compound that is produced when ink dries on paper, and that the more nearly the proportions of galls and iron-sulphate are calculated to form this tannate without excess of either ingredient, the more permanent will be the writing.

Many of the commercial inks of the present day deviate widely from this standard, and, as everyone must have noticed, the writing done with some of them will fade considerably, even in the course of a year or two.

Notwithstanding the probably closely similar methods of preparation, the composition of different kinds of ink shows wide variations. Thus, out of twenty-four different varieties of writing ink sold in this country, the writer has found the total amount of solid matter to vary from 1·89 to 7·94 per cent.; the ash from 0·42 to 2·52 per cent.; and the iron from 0·18 to 1·09 per cent.

Analyses made by the writer at intervals of three or four years have shown that the composition of the products of the same manufacturer shows but little variation. This is only what was to be expected, since, naturally, when a satisfactory article has once been obtained, great care is taken to keep it constant by using the same proportions of water, galls, dyestuff and gum.

In examining writing to ascertain whether it was done with a particular ink, it is advisable to prepare a colour scale with that ink, consisting of four washes ranging from the faintest to the darkest possible tone, and to leave this exposed to the air for at least twenty-four hours. The scale may then be compared under the microscope with different parts of the writing in question, and is subsequently used for comparative chemical tests when such are permissible. The broad surfaces of colour are comparable with the surfaces of the written characters as seen under the microscope, and there is thus obtained what practically amounts to a magnified record of the microscopical appearance.

Lovibond's tintometer will also be found useful in comparing the colours of different specimens of handwriting, and in matching the colours obtained in chemical reactions with those given by the colour scales prepared from known or suspected inks.

In some cases microscopical examination on these lines is sufficient to distinguish between the inks in different writings, without the necessity of applying chemical tests. The most striking instance of this kind within the writer's experience was in the Brinkley poisoning case. The will of an old lady named Blume had been forged by Brinkley, who, on the strength of being her heir, took possession of all the property. Mrs. Blume's relations contested the validity of the will, and Brinkley had, therefore, to prove that it was genuine. One of the witnesses whose signatures were on the will asserted that he had never signed a will at all, but that he had only signed a folded sheet of paper in a public house. As this witness, Parker, stood in the way, Brinkley attempted

COLORATIONS FIVE MINUTES AFTER APPLYING REAGENTS.

Inks.	Hydrochloric Acid.	Oxalic Acid.	Stannous Chloride.	Nascent Hydrogen.	Bromine.	Titanous Chloride.	Potassium Ferrocyanide.
Blackwood's	bright blue	bright blue	bright blue	deep blue	deep blue	green-blue	bright blue
Draper's	deep violet	red-violet	violet	violet	violet-black	maroon	deep violet
Field's	deep blue	deep blue	violet-blue	violet	deep blue	navy blue	blue
Mordan's	bright blue	bright blue	bright blue	bright blue	dark purple	dark green-gray	dark blue
Stephens'	deep blue	deep blue	violet	violet-blue	slight bleaching	nearly black	deep green-blue
Walkden's	bright blue	blue	bright blue	blue	blue	gray-blue	dark blue

to poison him by leaving a bottle of stout containing prussic acid at his lodgings: but, instead of Parker getting the stout, it was drunk by his landlord and landlady, both of whom died. As a great deal depended upon whether Parker were speaking the truth or not, the ink was obtained from the public house in question, and was compared with the writing upon the will.

As this ink happened to contain a particularly bright blue pigment as its provisional colouring matter, there was no difficulty in proving its identity with the ink in the disputed signature on the will. In fact three different inks were present on this will, the body of the document being written in one kind of ink, and the signatures of each of the witnesses in a different kind. Brinkley, cross-examined upon this point, stated that Mrs. Blume had kept three different sorts of ink, and that he had, after her death, given two of them to a little girl.

After a trial lasting four days he was found guilty of murder, and sentenced to death.

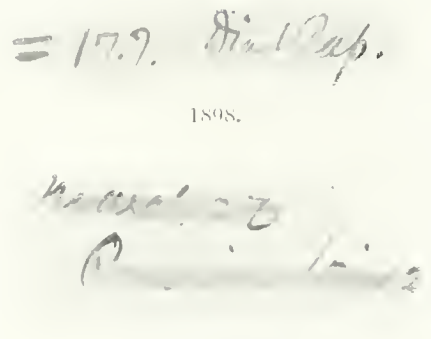
For the differentiation of writing by chemical methods a wide choice of reagents is available, but the following will usually be found sufficient:—(1) Hydrochloric acid (5 per cent. solution); (2) oxalic acid (5 per cent. solution); (3) stannous chloride (10 per cent. solution); (4) nascent hydrogen (50 per cent. HCl. with zinc); (5) bromine (saturated aqueous solution); (6) bleaching powder (saturated solution); (7) titanous chloride; and (8) potassium ferro-cyanide (5 per cent. solution, containing 1 per cent. of HCl.).

Of these reagents the two first act mainly upon the iron tannate and leave the provisional colouring matter. The third and fourth bleach the iron tannate and reduce the provisional pigment, changing its colour. The fifth and sixth reagents may act upon both pigments and cause more or less bleaching. The titanous chloride acts as a powerful reducing agent on both pigments, and the acidified ferro-cyanide solution acts mainly upon the iron liberated from the iron tannate.

The reagents should be applied with a brush, and the writing examined under the microscope by reflected and transmitted light, firstly after five minutes', and then after twelve hours' exposure to the air. The colorations appearing on the wrong side of the paper are also characteristic in some cases. In the tests with titanous chloride, blotting paper should be applied to the writing after the lapse of five minutes.

The method may be illustrated by the following results obtained with some of the best known commercial writing inks.

The question of determining the age of an ink in writing is much more difficult than that of deciding whether two writings are in the same or in a different kind of ink.



1898.

1908.

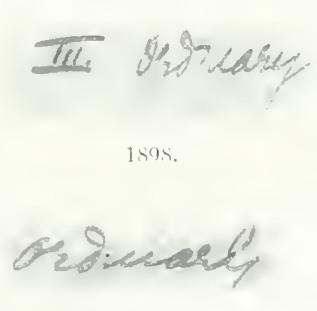
FIGURE 2.

Showing the action of oxalic acid on inks written in 1898 and 1908.

It is, as a rule, possible to distinguish colorimetrically between freshly-written and old writing up to about the sixth day, after which the iron tannate has become sufficiently oxidised to prevent further differentiation until after the lapse of two or three years or more, when the provisional pigment will have faded or have become fixed by the iron tannate.

In most cases, the provisional pigments employed, offer greater resistance to the action of chemical reagents, but are infinitely less stable than iron tannate when exposed to the action of light and air, and eloquent testimony to this difference is given by a comparison of certain manuscripts of the seventh and eighth centuries with type-written documents in aniline ink, which have been put aside for a few years.

Thus it happens that when writing done with blue-black ink is kept, the blue pigment will gradually fade out, leaving the black pigment, and when this stage is reached the ink in old writing is readily distinguished from ink that has recently been put on the paper.



1898.

1908.

FIGURE 3.

Showing the action of acetic acid (50%) on inks written in 1898 and 1908.

Prior to this, however, the blue provisional colouring matter appears to become enveloped in particles of the oxidised iron tannate, so that it no longer reacts rapidly with reagents.

Thus, if a writing done within the last year or two be treated with a fifty per cent. solution of acetic acid there is immediate diffusion of the blue pigment, whereas in a writing a few years older diffusion, if it takes place at all, is very slow and limited in extent (see Figure 3).

A still more useful reagent is a saturated solution of oxalic acid, which causes the pigment of relatively fresh writing to give an immediate smudge, but has very little, if any, effect on writing six or eight years old. The differences between the behaviour of old and relatively new writing in these tests is seen in Figure 2, in which the older writing of 1898 was scarcely affected, whereas the writing done in 1908 gave the results shown. Both writings were in ink of the same kind, and the tests were applied simultaneously.

Speaking generally, a writing done with blue-black ink ceases to show such diffusion after about five to six years. When slight diffusion occurs in an older ink it is seen, under the microscope,

to differ in character and only to affect the surface of the letters, whereas the diffusion in an ink written within the last two or three years affects the whole of the pigment in the letters.

The first occasion on which chemical evidence as to the age of an ink has been given in the law courts was in the recent forgery case, in which Colonel Pilcher was accused of forging his cousin's will.

This will was alleged to have been written in 1898; and assuming this to have been the case the ink should have only reacted very slowly with the different reagents: there should have been little or no diffusion with oxalic acid: and if any slight diffusion occurred this should only have been upon the surface of the letters.

The ink on the will, however, gave an immediate reaction with the different reagents, and diffused at once with oxalic acid, and the diffusion extended throughout the whole of the letters. There was thus no doubt as to the ink upon the will having been written within the last year or two, and certainly within the last six years.

Cheques written by the deceased lady during the last thirteen years were also subjected simultaneously to the same tests, and it was found that the ink upon those written in 1903 gave only a faint diffusion with oxalic acid in the heaviest writing, while no diffusion at all was obtained upon the cheques written in 1901.

The correctness of the conclusions drawn from these results was borne out by the confession of the prisoner, who, in the middle of his trial, pleaded guilty to having uttered the will knowing it to be a forgery, though he denied all knowledge of how it came to be forged.

SOLAR DISTURBANCES DURING AUGUST, 1910.

By FRANK C. DENNETT.

THE falling off in the number of spot disturbances was still noticeable during August. No dark spots were visible from the 20th until the 29th, except on the 27th, but faculae were present every day with the exception of the 29th. The longitude of the central meridian at noon on August 1st was 153° 3′.

No. 57, from the July list, is repeated in part upon the chart as it remained visible until August 2nd.

No. 58*a*.—A new group which broke out on the site from which No. 58 had disappeared only a few hours previously. On the 1st and 2nd it formed a double group of pores, which changed in appearance somewhat quickly. On the 3rd a spot had developed in each with two umbrae, the eastern one being largest, over 10,000 miles in diameter. By the 4th the western spot was gone, only two pores marking its position. The eastern spot with a pore following still remained, but shrank until only a tiny pore was visible amid faculae on the 6th, when it was last seen. The group had a length of 45,000 miles.

No. 58*b*.—A solitary pore only seen on the 5th and 6th.

No. 60.—On the 3rd a considerable spot came round the limb, which appeared on the 6th to be developing considerably. There were two umbrae in the large spot with two spotlets northward at first, these soon became enveloped in penumbra, another penumbral spot appearing to form close to the eastward. The spot increased to 22,000 miles in diameter, and on the 7th was partly surrounded by pores, some of which continued till the next day. Two pores had opened nearly south on the 10th, when the eastern part of the main umbra had become distinctly reddish, and a penumbral marking formed on the east side, a little to the south. There was very little change on the 11th, but from the 12th to the 14th the penumbra had a bright fringe at the inner edge, whilst there were two spotlets south of the large one. On the 14th and also on the 15th when last seen faculae extended for some degrees north and south of the spot.

No. 60*a*.—A pair of pores was seen on the 8th in a faculic patch, one of which continued until the 11th, faculae afterwards marking its position. On the 10th and 11th there was also a minute pore between 60 and *a* about in the position of the tiny cross.

No. 61.—A disturbed district some 20° in length had sometimes shown minute pores since the 11th, but when close to the central meridian on the 16th, a group of about six pores broke out 55,000 miles in length. The pores changed in position and number, and were last seen on the 19th, faculae marking the district until it reached the limb on the 22nd.

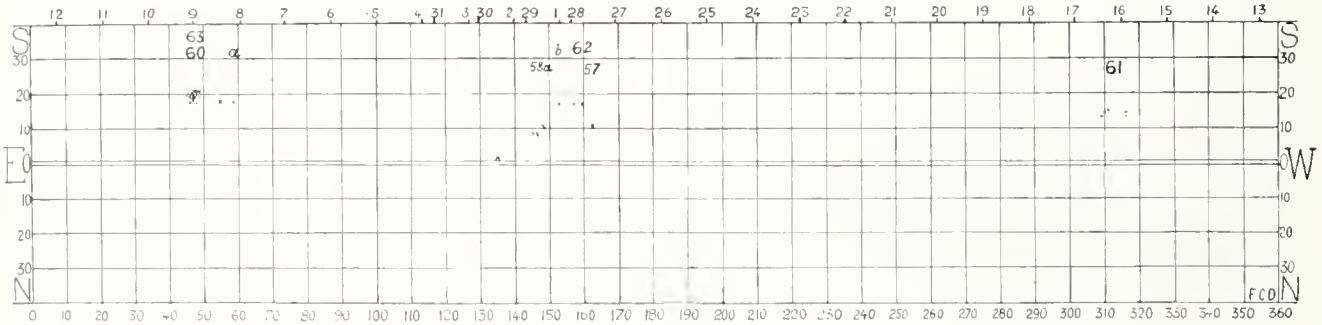
No. 62.—Two pores, separated by 26,000 miles, were only seen on the 27th, the western being the larger.

No. 63.—A return of 60 as a spot 15,000 miles in diameter, with the inner edge of the penumbra brightly fringed. Seen very near to the limb on 30th. A pore was noticed close by on the 31st. A bright jet over the umbra from the east on September 2nd and 3rd, and from the south 7th and the 8th. It was last seen close to the west limb on the 11th.

On August 1st a disturbed looking region was close to the equator, and contained a tiny pore too small for measurement, near longitude 134°, where a cross has been marked.

The chart has been made from the joint observations of John McHarg, A. A. Buss, E. E. Peacock, and F. C. Dennett.

DAY OF AUGUST.



THE DESTRUCTION OF WEEDS BY CHEMICAL MEANS.

By HAROLD C. LONG, B.Sc.

(*Author of "Common Weeds of the Farm and Garden."*)

DURING the past twenty years an increasing amount of attention has been devoted to the economic side of insect and fungous pests, with a view to their extermination, and The Destructive Insects and Pests Act of 1907 gives the Board of Agriculture and Fisheries power to deal with the whole question, and carry out compulsory preventive and remedial measures in the case of such species as they consider of sufficient importance to schedule in their Orders.* The attention of scientific workers has for many years been turned to the necessity of acquiring a thorough knowledge of the life-histories of all the worst insect and fungous pests of the farm, garden, and orchard, and a vast fund of information has been acquired by a systematic study of individual species. Such study, in conjunction with experimental work, has been necessary in order to eradicate the particular pest concerned, and here also much has been accomplished, even though it be said that much remains to be done.

What, however, is the position in regard to the prevention and eradication of the common weeds of the farm and garden which annually cause so much loss to the grower of crops? It may be said that a good deal has been done to enable the unbotanical worker to identify species, and a few practical botanists and agriculturists have offered sound advice as to the mechanical destruction of weeds. Yet the information available is still quite inadequate, and while some of the highly farmed lands are more or less weedless, the majority of farmers meet with two or three species of weeds which they experience extreme difficulty in combating. The question of weed eradication is one of real difficulty, and when we bear in mind the fact that many serious insect and fungous pests are supported and distributed by weeds, it assumes an importance which the entomologist and mycologist would do well to recollect. Professor Somerville has written:† "Using the term in its wisest sense *good cultivation* will be found to be the best protection that the farmer or gardener can offer his crops against insects," and good cultivation includes the destruction of weeds. In many countries the importance of destroying weeds has long been officially recognised, and Acts have been passed requiring the destruction of specified weeds. In Great Britain, however, the only laws of the kind refer to Ireland and the Isle of Man.

FIGURE 1.

Charlock (*Sinapis arvensis* L.) × ⅓. This weed is readily destroyed by spraying with a solution of copper sulphate or iron sulphate.

THE PREVALENCE OF WEEDS.

We have said that some highly farmed lands are more or less weedless, but it is undoubtedly true that most farms are far more weedy than they either ought to be or need be. In the third week of August, 1909, we found in an area of perhaps a hundred square yards of a wheat field no less than twenty-nine species of weeds, the majority of which were among the most troublesome of all (including the species illustrated in Figures 1, 5, 6 and 8). Similar cases could be quoted. We consulted twenty-nine experts in different parts of the country, from the North of Scotland to the South of England, and species of "couch or twitch" were included thirty-two times among the six worst weeds of arable land, charlock and runch twenty-eight times, docks sixteen times, thistles sixteen times, coltsfoot thirteen times, and so on. As regards grass land, thistles were regarded as the worst in twenty-two cases, buttercups sixteen, Yorkshire fog (*Holcus lanatus* and *H. mollis*) nine, docks eight, and so forth. These figures show that the species named

* The Destructive Insects and Pests Order of 1910, schedules sixteen "destructive insects and pests," whose presence on any premises must be notified to the Local Authority or to the Board of Agriculture and Fisheries.

† Farm and Garden Insects, p. 30.

are not only widely distributed, but in the cases mentioned are real pests of farmers. In good garden soil, well cultivated for three years, we found one thousand and fifty seedlings in a square yard on May 17th, 1909, and of these seedlings six hundred and fifty-four were those of creeping buttercup, one hundred and seven *Poa annua*, and sixty were a species of dock. Many seedlings were subsequently destroyed on the same square yard. Plenty of other evidence as to the prevalence of weeds could be adduced.

FIGURE 2.

Persicaria or Redshawk (*Polygonum Persicaria* L.) × ½. This is a pest of good arable land and gardens. It has been quite destroyed by a 4 per cent. solution of copper sulphate (100 gallons per acre).

FIGURE 3.

Petty Spurge (*Euphorbia Peplus*), natural size. This weed is very common and plentiful in some districts. It appears to be protected from spray fluids by a glaucous bloom on the leaves.

THE HARM DONE BY WEEDS.

Many pages could be written dealing with the losses caused by weeds, but the matter can only be briefly mentioned here. It may be stated, however—and most readers of KNOWLEDGE will doubtless fully understand the statements without further explanation—that weeds take up the space which should be occupied by the cultivated plant; weeds rob the crop of food and moisture, and of air, light and heat; they hinder thorough cultivation, harbour injurious insects and fungi, are parasitic on crops, may be poisonous, stop up drains, and their seeds may very seriously reduce the value of those of agricultural plants, which hence require very thorough cleaning, involving considerable expense. In short, the cash losses due to weeds are very serious. The following examples will suffice:—

(1) The nitrogen in the dry matter of Persicaria (*Polygonum Persicaria*) was found to equal nearly 20 per cent. of albuminoids.*

(2) A twenty-five-bushel crop of wheat was found at the Agricultural Experiment Station of Cornell University to transpire (during growth) five hundred tons of water. Weeds probably transpire to a somewhat similar extent.

(3) Charlock (*Sinapis arvensis* L.) and other crucifers are hosts for the Turnip Flea Beetle or "Fly" (*Phyllotreta nemorum*), the Turnip Gall Weevil (*Ceutorhynchus sulcicollis*), the Diamond-Back Moth (*Plutella maculipennis*), Finger-and-toe of Turnips (*Plasmodiophora brassicae* Wor.), *Peronospora parasitica* De Bary, and other pests.

(4) Wollny has placed the annual loss of crops due to weeds in Bavaria at an average of 30 per cent.† Korsmo found the percentage loss in money value on a weedy compared with a clean plot of barley to be 46 per cent., and in the case of potatoes 49 per cent.‡ Experimental plots at University College Farm, Reading, showed that with two hoeings only after "singling"

FIGURE 4.

Corn Cockle (*Agrostemma Githago* L.) × ⅓. Not only a weed in the usual sense, but it is poisonous in a degree. Spraying is partly effective and generally prevents seeding (see text).

* Stutzer and Seidler, *Fühling's Landw. Zeitung*, June 15th, 1908, p. 429.

† Fr. Maier-Bode, *Die Bekämpfung der Acker-Unkräuter*.

‡ *Tidsskr. Norske Landbr.* 10 (1903.)

mangolds yielded over thirty-seven tons per acre, but when unweeded the yield was only slightly over sixteen tons per acre.

(5) If the real value of agricultural seeds, owing to impurity and low germinating power, be only 76 per cent., then the (initial) loss in cash would be 24s. in £5 if bought at the rate for best seed.

The Distribution of Weeds.

Regarding the manner in which weeds are distributed, it may be said shortly that the seeds are scattered in the same general way as with other wild plants—by transportation through the agency of man, railways, shipping, and so on; by rivers and floods, by birds and wild animals, by wind (owing to extreme lightness of the seeds or to their bearing flight organs), and by seeds adhering to animals (or man) by means of hooks, and so forth. In other cases broken portions of the rootstock may be transported and give rise to new centres of infestation.

Coöperative Destruction of Weeds.

We may now consider the means at the disposal of the farmer for the purpose of destroying weeds, and all may be covered by coöperation, which should be devoted to: (1) The supply of pure seeds, free from the seeds of weeds; (2) The mechanical destruction of individual species which may prevail in a given district, by means of the ordinary routine methods practised on the farm, as well as by special measures; and (3) The destruction of weeds by spraying.

If farms are to be kept free from weeds, and farmers are to be prevented from causing infestation of a neighbour's farm by neglect of their own, it must be by compulsory eradication or by coöperation—*farmers must work together.*

Figure 5.

Field Mint (*Mentha arvensis* L.) × ½. Pest of arable land, and most difficult to eradicate owing to the creeping root-stocks.

From a photograph *By J. C. Varty-Smith.*

Figure 6.

Knot-weed (*Polygonum Aviculare* L.) reduced. A serious trouble of farmers. Often occurs in incredible quantities on light sandy soils.

Regarding (1) it is clear that a combination among say fifty farmers in a district will enable them to purchase large lots of high-class seeds at a fair price, under guarantee, and to have them sampled and tested. A pure seed supply will thus be ensured.

In relation to (2) it may be suggested that mechanical destruction should include coöperative eradication of docks and thistles by the use of docking irons, spuds, thistle cutters; regular cutting of many weeds by hand and by power machines; cutting of weeds on waste lands and roadsides to prevent the formation and distribution of seed; the collection of seed shed at harvest time by the use of box attachments to reapers and binders; thorough cleansing of thrashing machines before they go to the next farm; coöperative purchase and use of surface weeders like the poppy killer, American weeder; and so forth. A year or so ago Dr. Ewart, Government Botanist of Victoria, suggested[*] that school children should be offered prizes for collecting certain weeds. A police magistrate offered prizes, and 12,000 plants of Ragwort (*Senecio Jacoboea*) were brought in during the first four days, the number quickly rising to 20,000 plants.

(3) The destruction of weeds by spraying is what most concerns the readers of this journal, and is dealt with below.

The Destruction of Weeds by Spraying.

It is only in recent years that attempts have been systematically made to destroy weeds by means of chemical substances, these having been chiefly applied in the form of simple solutions. The

[*] *Journ. Dept. Agric.*, Victoria, 1908.

method appears to have originated in France, where M. Bonnet found,* about 1896, that a solution of copper sulphate destroyed charlock (*Sinapis arvensis* L.) without permanently injuring the cereal crop among which it grew.† Attention was directed to this fact in the English press, and a host of experimental trials were soon conducted, the result being that the facts were quickly established, and in 1900 a leaflet on the destruction of charlock by means of spraying with the sulphates of iron and copper was issued by the Board of Agriculture. Forty gallons of a 4 per cent. solution of copper sulphate, or a 15 per cent. solution of iron sulphate, may be sprayed over an acre of the crop when the charlock is about three inches high, and if the operation be properly performed during suitable weather, the weed will be destroyed and the cereal remain practically uninjured.

FIGURE 7.

Spurrey (*Spergula arvensis* L.) × ⅓. This plant is one of the most troublesome weeds on light sandy soils. Being an annual it is only necessary to prevent the ripening of seed. It has been found that a 5 per cent. solution of copper sulphate destroys it.

It is believed that the rough, broad, more or less horizontal leaves of charlock catch and retain the solution, while the narrow, smooth, practically vertical leaves of the cereal throw it off, and hence are not damaged. In this connection there is room for further investigation, and it may be commended to the chemist and botanist alike as a source of interesting research.

Since the introduction of spraying for the destruction of charlock, a number of experiments have been carried out by many investigators, who have made trials with a variety of plant poisons, the effects of which have been observed when applied to a number of species of plants. Though the results are interesting and some information has been obtained, they are by no means conclusive, but it will be useful to refer here to some of the experiments and their results.

In the course of experimental work in spraying charlock (Figure 1) with iron sulphate, in 1898, it was found by Professor Somerville‡ that both at the Northumberland County Farm, Cockle Park, and in the grounds of the Durham College of Science (Newcastle-on-Tyne), all rough-leaved plants, such as thistles, and, to a lesser extent, coltsfoot (*Tussilago Farfara* L.), were crippled; while glaucous plants, like species of *Chenopodium*, were not affected.

It is well known that broad-leaved plants are often scorched when nitrate of soda is broadcasted on them. It was stated ten years ago§ that a solution of 15 to 40 per cent. of nitrate of soda and

FIGURE 8.

Black Bindweed. (*Polygonum Convolvulus* L.) × ⅔. A most mischievous annual, the twining branches of which may be several feet long and drag down cereal and other crops. Partly destroyed by spraying with copper and iron sulphates, seeding being largely prevented.

* *Journ. d'Agric. Pratique*, 1897.

† As noted below, Mr. H. L. Bolley started spraying investigations in the United States in 1896, and says they were perhaps the first experiments of the kind conducted in any country.

‡ *The Field*, July 9th, 1898. § *The Times*, October 8th, 1900.

sulphate of ammonia sprayed on young charlock plants in the early "rough leaf" stage caused them to begin to wither in a couple of hours. Chloride of potassium is said to have a similar effect on charlock when applied in solution.

About seven years ago Mr. G. F. Strawson stated* in regard to copper sulphate that: "It is now admitted that mangolds, as well as beans, peas, tares, wheat, oats, and barley can be sprayed without injury, and the charlock among them destroyed, and that the spraying does no harm to the young grass seeds, clover, sainfoin, and so on, growing in the crop." Evidence on this point, however, is conflicting, as we shall see, and in Germany, V. Rümker, only last year, held that spraying sugar beets with sulphate of iron is hazardous.† (There may be some difference in sensitiveness between mangolds and sugar beets, and also in the methods of spraying). Only this summer Mr. Strawson repeats that mangolds have been constantly sprayed during the last seven or eight years, and that he has never heard of a single instance where the crop was appreciably injured. He also repeats that corn, tares, sainfoin, clover, beans (and peas in most cases), can be safely sprayed with pure copper sulphate to eradicate charlock.‡ The statement regarding mangolds was confirmed a week later in the same journal by another writer.

From a photograph by H. C. Long.

FIGURE 9.

Yorkshire Fog. (*Holcus lanatus* L.) A great trouble in many pastures. Very common and widely distributed. A hairy grass refused by stock.

A good deal of experimental work in spraying has been conducted at the North Dakota Agricultural Experiment Station by Mr. H. L. Bolley, and some of his results are interesting.§ His experiments commenced in 1896 with copper sulphate and mercuric bichloride, and the results in killing charlock without injury to wheat are described as surprisingly successful. Bolley found that the best time to spray is when the crop and weeds are making rapid growth, that slow-growing weeds are hard to kill, and that the more succulent the weeds the more easily are they destroyed. Sodium arsenite in preliminary experiments was usually much more efficient as a weed destroyer than the sulphates of iron and copper: it acts quickly, destroying the weeds (apparently charlock and "king-head") even though rain follows within a few hours. Referring to the two sulphates Bolley concludes (in Press Bulletin No. 27, 1907): "These substances are recommended here for mustard and king-head, and will dispose of other annual weeds which they thoroughly wet, including Red-River weed, common rag weed and pepper grass, and will much weaken and retard the development of the French weed, wild buck wheat, black bindweed, rose bushes, wild docks, Canada thistle and many other of the destructive weeds which invade cereal crops." In Bulletin No. 80 (1908) Bolley shows that at the North Dakota Station they have successfully used, in various sorts of weed eradication work, common salt, sulphate of iron, sulphate of copper, corrosive sublimate and sodium arsenite, but because of its cost and its extremely poisonous character the corrosive sublimate (mercuric bichloride) is not recommended for weed killing, while the arsenite must be used with great caution.

(To be continued.)

THE HABITS OF CATERPILLARS.

By L. J. WINTER JOYNER.

With Illustrations from Photographs by the Writer.

BOTH the subjects of the following notes are American, from the State of New York.

The very singular caterpillar (seen in Figure 1), with the white ivory spots, is that of the Emperor Moth (*Dryocampa imperialis*).

The moth is a large purple-banded, buff-colored insect; but it is most remarkable for the very singular manner in which it feeds in its larval condition. In spite of its generic name of *Dryocampa* meaning, primarily, oak caterpillar, the creature is usually found on the pine, preferring perhaps *Pinus strobus* to all other pines. Seen in the branches and looked at from under the tree the grub, from its dark olive-green complexion, more than a little resembles the young cones of this pine, but any doubts of its identity may be dispelled by the presence of recently dropped "frass," which is of a colour not readily distinguishable from that of the carpet of dead pine needles beneath the tree.

In the accompanying photograph, especially in the

* Fifth Annual Report on the Destruction of Charlock in Corn Crops in 1903. † *Deut. Landw. Presse*, Feb. 6th, 1909.
‡ *Farmer and Stock Breeder*, June 13th, 1910. § Press Bulletin No. 9, 1903; Press Bulletin No. 27, 1907; Bulletin No. 80, 1908.

smaller, vertical branch, many of the fascicles, which in *P. strobus* consist of five leaves, will readily be seen to have been eaten down quite close to the brown scales at their base.

Figure 1.

The larva of the American Emperor Moth eating pine needles.

For hours the writer has watched this insect feeding. It proceeds thus. After taking up its position within convenient reach of a whole bundle of five, the caterpillar demolishes them singly, or in twos, more often singly, but never three at a time. It grasps one or more needles with its six permanent legs, grotesquely enough using them apparently as three pairs of hands and fingers, beginning by hauling at the base of the leaflet or leaflets and gradually passing them through its "hands" until it has brought down the tip of the leaf to its mouth. Then, whilst feeding, the opposite process of handling (or walking, pacing backwards) is kept going until at last it has nibbled down the one or two leaves (as the case may be) to the stump end. In this way it invariably, and thus economically, deals with the remainder of the bundle sampled, until it has made a clean business of its work, and not till then does it attack another fascicle.

Occasionally the grub grasps three or more needles at the start; but it does not appear to be able to hold more than two at a time, as the others, in such case, fly out of its grasp.

The more slender twigs are cleaned up all round, but in the case of the large twigs, owing to the possibility of the beast getting a foothold without embracing the whole branch, a clean sweep of the vegetation is frequently made only on one side. This point is well borne out in the illustration.

The photograph of the group represents a brood of the larvae of the Handmaiden Moth (*Datana ministra*), of the family Bombycidae.

The perfect insect is in no way particularly remarkable or striking. The caterpillar is known as the Yellow-necked Appletree Caterpillar, and is, when full grown, about two inches long, with a large black head, the next segment being dull orange, and the rest of the body striped with black and yellow.

The larva of this insect, like that of the British Lobster Moth, has the singular habit, when at rest, of throwing its anterior part backwards and its posterior portion forwards. This attitude is only feebly assumed when at rest and undisturbed, but, on the moment of alarm, it instantly strikes its more severe attitude, when its extremities become rigid, the head and tail almost meeting, as appears on the left-hand side of the group in one individual at the top.

The brood depicted is on the Witch Hazel (*Hamamelis virginica*). The very slight stir of a bird settling on the parent branch, or even the footfall of a person passing near the occupied bush has, within the writer's personal observation, thrown them suddenly into the severe attitude, which they continue to maintain for many minutes without betraying movement or sign of life. At a passing glance at such a time the massed brood strongly resembles a fulvous mossy patch of hypertrophied vegetable growth, such as very commonly protects the homes of certain gall-producing insects.

Figure 2.

Gregarious Caterpillars of the Handmaiden Moth.

The Observatory at Greenwich showing the new buildings erected during Sir William Christie's period of office.

SIR WILLIAM CHRISTIE AND GREENWICH OBSERVATORY.

By E. S. GREW, M.A.

It is no exaggeration of phrase to say that Sir William Christie, whose period of office as Astronomer Royal expires this year, has given to Greenwich Observatory the devotion of a life-time. The Observatory as a modern implement of astronomical research is of his making: and during his generation astronomy has become by the multiplication of its instruments an immeasurably more complex science than in the preceding period of its history. In essence, its foundation, which is that of the attainment of the highest degree of accuracy, remains the same; but with each new instrument designed to approximate

Greenwich Observatory in the time of the previous Astronomer Royal.

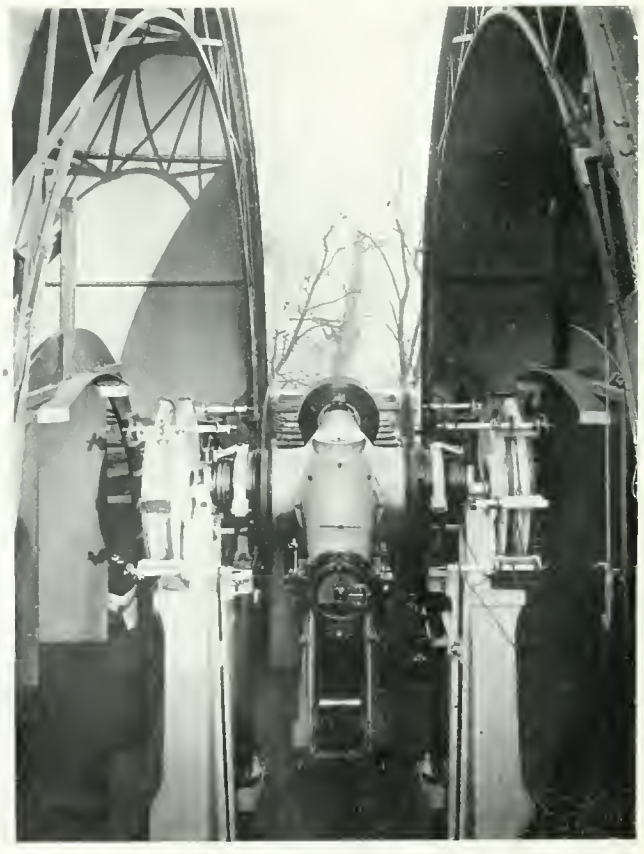
more closely to accuracy new difficulties appear. The

The Altazimuth Building.

horizon recedes with the stature of the Observatory.

The most obvious advance which has been made in Sir William Christie's time has been in the multiplication of telescopes and in their increasing size. When Sir George Airy, the preceding Astronomer Royal, mounted a thirteen-inch telescope at Greenwich in the fifties, he did so, says Professor H. H. Turner[1], in the earnest hope that its use should not interfere with the proper work of the Observatory, which was to be done with instruments distinguished for their steadiness rather than their size. But since Airy's day a twenty-eight inch telescope has been set up where the old telescope stood: and is, indeed, economically attached to the old mounting. The thirteen-inch is now used as a sighting telescope. In addition to the twenty-eight inch refractor there is the Thompson Equatorial. Sir Henry Thompson presented to the Observatory a large photographic refractor of twenty-six inches aperture: and attached to the same mounting, like the second prong of a two-pronged fork, is a beautiful reflecting telescope which was made by Dr. Common, of Ealing. Sir Henry Thompson, seeing how much this addition would enhance the value of his own gift, hastened to increase his original estimate of the mounting, and thanks to his generosity and that of Dr. Common, Greenwich Observatory possesses one of the most serviceable "large" telescopes in the world. The thanks are due, it will be noted, to private benefactors, not to the taxpayer.

The mention of the Thompson twin telescope directs attention to the implement of research in astronomy—the use of photography—which is perhaps more important than any other which has been devised since the time of Airy. As long ago as 1873 a beginning was made with photographing the Sun by means of a photo-heliograph at Kew—in the Observatory which now stands in the middle of the Mid-Surrey Golf Course—and these photographs were studied and measured at once, so that the Greenwich Observations are in this, as in other fundamental work, the standard reference for records of Sun-spots. A larger instrument for solar work has since been presented to Greenwich Observatory,[2] and is under the charge of Mr. W. E. Maunder; and by arrangement with the Observatories of India and the Cape (and formerly of Mauritius) a complete daily photographic record of the Sun is now kept. But the photographic plate subserves many other astronomical purposes. In 1887 the International Conference on the Photographic Star Map of the Heavens met at Paris, and the great project of mapping the skies by photography, which owed its inception to Sir David Gill and the late Admiral Mouchez, Director of the Paris Observatory, was entered upon. One of the most important resolutions of the Conference decided the pattern of



The Altazimuth.

[1] "Modern Astronomy," p. 28 (Constable).

[2] Also by Sir Henry Thompson.

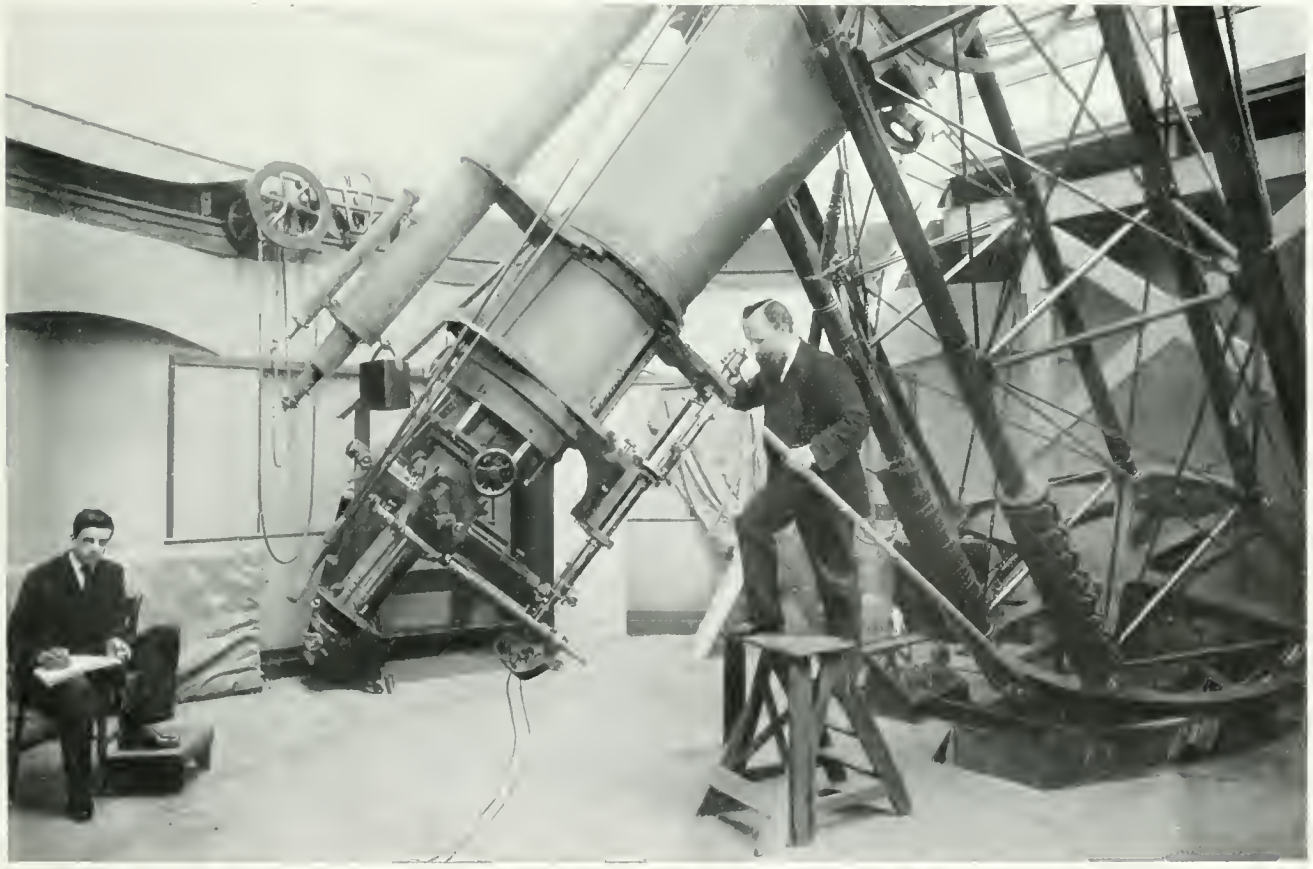
instrument to be employed by the eighteen observatories which shared the work. Of these Greenwich was one, and an instrument of the standard pattern — the Astrographic Telescope — was erected at the Observatory. With this instrument the share of Greenwich in the great work has been completed, and it is now helping Oxford University Observatory in the Oxford share of the work. In the section of the International Chart and Stars Catalogue allotted to Greenwich, the positions of nearly 180,000 stars have been measured in duplicate, and about 65,000 enlarged prints of the Chart plates have been made at the rate of 12,000 to 13,000 a year.

The building containing the twenty-eight inch equatorial telescope.

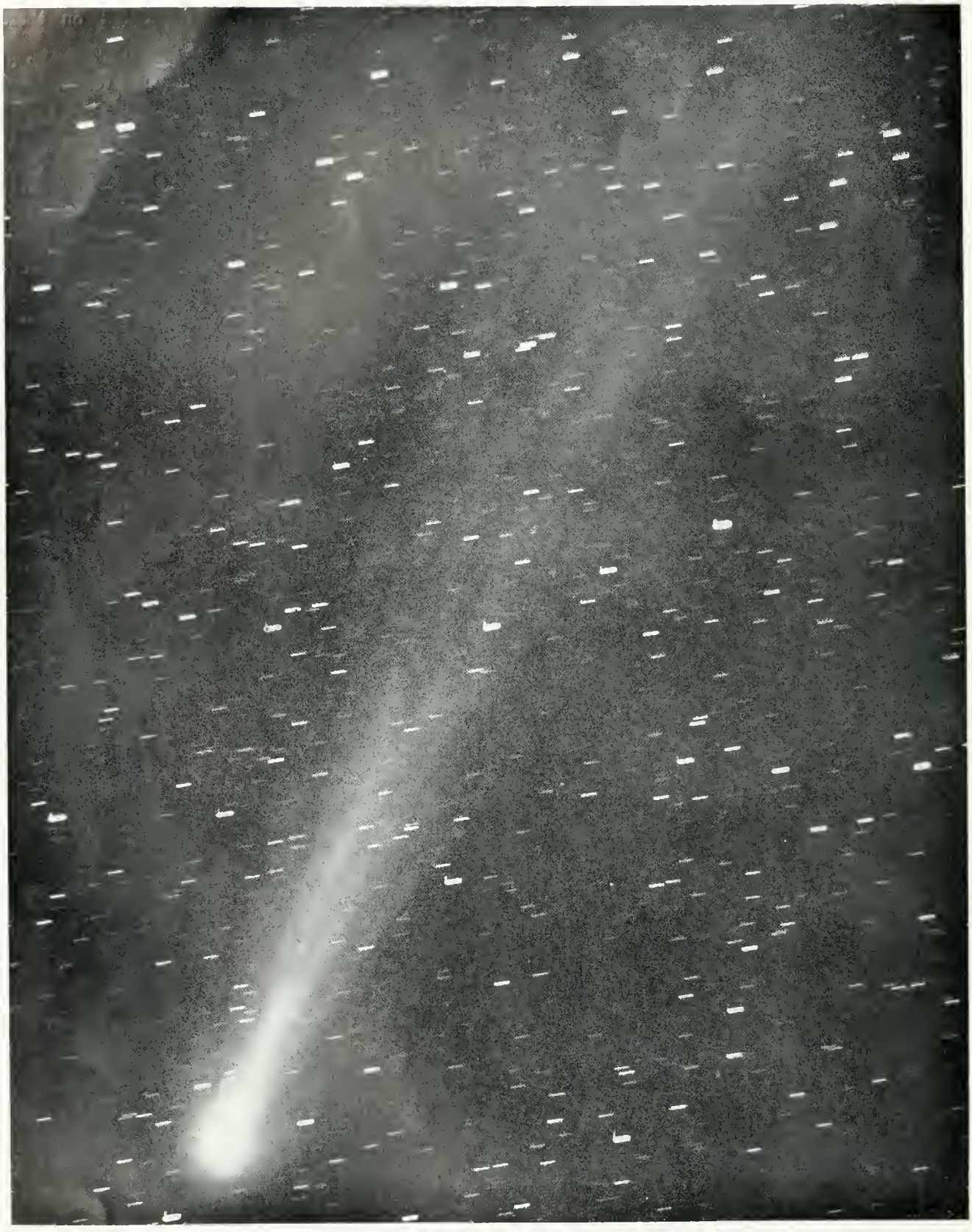
Nearly 720,000 stars have been counted on these plates.

It is not unworthy of remark that the first impulse towards this photographic chart of the skies was received when Sir David Gill at the Cape Observatory successfully photographed the Comet of 1882 — a task of great difficulty, for the dry plate was not then in use.

The Thompson Equatorial has been devoted assiduously to the photography of faint satellites, comets and planets. The chief objects of Greenwich have always been those of computation and of accurate observation rather than of "discovery," but it is worthy of note that all discoveries of planetary satellites since the seventeenth century



The twenty-eight inch equatorial telescope; observing with the spectroscope.



Comet "c" of 1908: taken October 27th at $6^h\ 41^m$: exposure 15 minutes.

Comet "c" of 1908: taken September 29th at $13^h\ 12^m$; exposure 50 minutes.

have been made in England or in America, and are at present equally divided between the two countries, the share of each being eight. To Greenwich Observatory belongs the credit of the last of these discoveries, that of the eighth satellite of Jupiter, which was found on a plate taken by Mr. Melotte. The minuteness of the work of "discovery" may be gauged from the fact that it takes, on an average, four hours to find the image of a satellite on a plate

The Thompson equatorial: the twin refractor and reflector. The largest instrument at Greenwich.

even when one knows where to look for it. In cometary photography the Observatory has been as successful as the climatic conditions allow; and it possesses a remarkable series of photographs, numbering upwards of one hundred and fifty, of Morehouse's Comet. They are now awaiting examination in the hope, and with the view, of elucidating some of the problems of cometary structure.

In addition to the multiplication of observations which these implements imply, is the additional work done with all the instruments. With the old Transit Circle, set up with such meticulous care by Airy,* the number of annual observations has increased from four thousand to ten thousand a year. With the new Altazimuth erected by Christie in place of the old, the number of observations has been quadrupled. The old Reflex Zenith Tube, once all but abandoned because the movement of the Pole and the variations of latitude, due to the imperfect rigidity of the Earth, were unsuspected, and seemed to make the instrument's observations all wrong, now does valiant and invaluable work. In addition to this, and in addition to its refined work of observation of the Double Stars, Greenwich pursues all the modern investigations which have been imposed by the science of Spectroscopy. Spectroscopy and Sir William Huggins's work date from a time anterior

The transit circle: the fundamental instrument at Greenwich.

to the Christie era, but the greatest advances in Astrophysics have been made since the general use of the gelatine dry plate; and the spectroscopic apparatus which Greenwich now uses is due to the initiative of its Director.

It remains only to notice that all these new instruments and methods have changed the face of Greenwich Observatory as the spectator sees it. New domes for protecting the instruments have sprung up; new libraries, computing rooms, storehouses and workshops have been added, so that (again to quote Professor Turner) the Octagon Tower, which was the whole Observatory at its foundation in 1876, and remained its chief architectural feature for two centuries, is now rivalled by a stately building of cruciform shape at the south end of the grounds, and the Seven Domes of Greenwich, when seen from a distance, have the appearance of a small astronomical city set on a hill.

* The contractors for the work were dismayed by Sir George Airy's demands for accuracy of adjustment. He insisted on pivots accurate to within $\frac{1}{3000}$ of an inch.

STALACTITES.

By GEORGE H. MARTIN, M.A., F.C.S.

It is a matter of common experience in everyday life that when an article appears to be hopelessly lost, it is often found again in the process of looking for something else. So also in the domain of science, when experiment after experiment has failed in the search for the constitution of a compound for a method of preparing some substance on an advantageous commercial basis, or what not, the clue to the problem is frequently found in the course of an entirely different investigation.

In the case in point, for example, attempts were being made, in connection with a course of lessons in Elementary Geology, to prepare stalactites in the laboratory. The process seemed simple enough: all that was necessary, theoretically, was to allow a solution of bicarbonate of calcium to drop slowly from a small aperture and patiently to await results. Nothing, however, happened, although the experiment was tried in several ways. About the same time, for a different purpose, a burette full of lime-water was so arranged that the lime-water dropped from it with extreme slowness. This experiment also failed: but for some reason the apparatus was not dismantled, and the burette was left for some weeks with the lime-water still dropping slowly. When, however, the burette was again examined, it was noticed that a slight deposit was forming around the aperture of the nozzle, and it seemed just possible that if the process were allowed to continue a stalactitic growth might form at the end of the burette.

And so it proved,—a strange result when one considers that of the two experiments, one of which was started in the hope of making a stalactite, this was the one that was not begun for that purpose.

The growth of the stalactite was watched with much interest, and it proceeded with comparative rapidity. At the end of six months it had reached a length of one inch and a half, which means a growth at the rate of $\frac{1}{150}$ inch per day. The stalactite grew in the form of a hollow tube, not quite straight but gently waved (see Figure 1), and of approximately the same diameter throughout its length. The growing end of the tube was fringed with tiny fern-like projections which clasped the pendant drop as a jewel is grasped by its setting. Through a microscope it presented a beautiful appearance.

The projections were then seen to be fronds of crystalline growth—wonderfully fern-like in appearance and sharp in outline (see Figure 2). The drops, which at the beginning of the experiment soon became milky, afterwards remained perfectly clear the whole time they were forming: no separation of opaque calcium carbonate appeared to take place.

At the end of six months it was desired to show the stalactite at the Annual Meeting of the Public Schools' Science Masters' Association (January, 1910), so the experiment was stopped and the burette was emptied and carefully laid on its side. Then, with the point of a knife the "stalactite" was detached from the burette with the utmost care, and successfully introduced into a glass tube on a cushion of cotton wool, where it still remains. In appearance, it is a delicate, cream-coloured tube of interwoven silky crystals, its whole weight being only one-fifth of a gram.

The drops of lime-water had fallen from the burette at intervals of about three and a half hours, making a total of eight drops, that is, about three-quarters of a cubic centimetre per day. The drops fell upon a watch glass, where they evaporated to dryness, leaving a slight and apparently amorphous deposit.

It is interesting to compare the weight of the stalactite given above with the maximum weight of calcium carbonate theoretically obtainable from the amount of lime-water used. Three-quarters of a cubic centimetre a day mean about 137 c.c. in six months (the burette was replenished as required from time to time), and since the solubility of calcium hydroxide in water at the ordinary temperature of a room is ·14, the above volume of water will dissolve ·19 gram of calcium hydroxide at that temperature if a saturated solution is formed; and ·19 gram of calcium hydroxide contains ·144 gram of calcium oxide, which is equivalent to ·257 gram of calcium carbonate. The stalactite itself weighs ·2 gram: the difference being due partly to the fact that some of the stalactite remained adhering to the burette, and partly to the fact that some of the lime remained in the drop as it fell: and further, the lime-water in the burette, even if fully saturated at the start, did not remain so, but there was always a certain amount of amorphous calcium carbonate precipitated from the solution, as may be seen at the bottom of the burette in the first photograph. The volume of carbonic acid gas required to form the calcium carbonate of which the stalactite is composed would be contained in about one hundred and thirty-three litres of ordinary air. It might be noted here that the stalactite grew in a room which was only occasionally used, and for only short periods, so that the percentage of carbonic acid gas in the air would correspond pretty closely with the normal value.

So much for the facts: how do they compare with the generally accepted theory of the formation of stalactites, viz., that they are invariably produced by the deposition of calcium carbonate from a solution of bicarbonate of calcium? Here we have an obviously stalactitic growth formed by the dropping of a solution not of bicarbonate of calcium but by one of lime, so that an alternative method of formation seems possible. Do the conditions necessary for this alternative method ever obtain naturally? Is lime-water ever dropping through the

in conditions similar to those in which it drops from the burette in the above experiment?

The answer to these questions is apparently, yes. It has been tacitly assumed by geological writers that the stalactitic deposits formed under railway and other arches are produced in precisely the same manner as the stalactites and stalagmites of a lime-stone cavern. But is this so, at any rate in the earlier stages?

Figure 1.

A Stalactite forming on a burette from which lime-water is slowly dripping.

Is it possible for the whole of the lime—that is, for one third or one fourth of the whole bulk of the mortar contained in the two to three feet in thickness of brick, or stone work, which usually compose the masonry of a newly-built railway arch—to be changed into carbonate of lime by the time that the first signs of stalactitic growth appear? Apparently not, for according to Mr. Dibdin, in his "Lime, Mortar and Cement," the absorption of atmospheric carbonic acid gas by mortar, although at first rapid, gets gradually slower. "Mortars even centuries old are said to still contain appreciable quantities of hydrate of lime." This being so, it seems incredible that there could be any free carbonic acid gas available for dissolving calcium carbonate, at any rate in mortar under ordinary conditions; although it may be possible for the mortar in damp railway arches, through which rain-water is constantly passing, to become saturated with the gas more rapidly. However this may be, the fact remains that this complete transformation is not necessary: stalactites of carbonate of calcium can be formed from lime-water in contact with the carbonic acid gas of the air, and the general similarity in appearance between the stalactites of such bridges—hollow fragile tubes of approximately even diameter—and the artificially-formed stalactite described above, points to the conclusion that these stalactites and those of lime-stone caverns are due, at any rate in their initial stages, to quite different causes. In the case of the railway and other arches, the rain-water percolating through the mortar must dissolve some of the lime, the carbonic acid gas in the rain water combining at the same time with another small portion of lime, thus rendering it insoluble in the water which has already lost its carbonic acid gas; so that the drops issuing from the under surface of the arch must consist practically of lime-water. As shown above, lime-water will form stalactites when allowed to drop slowly, so that stalactitic growth may start very shortly after the brick-work has been put into position—as soon, that is—as the mortar in it becomes saturated with rain-water.

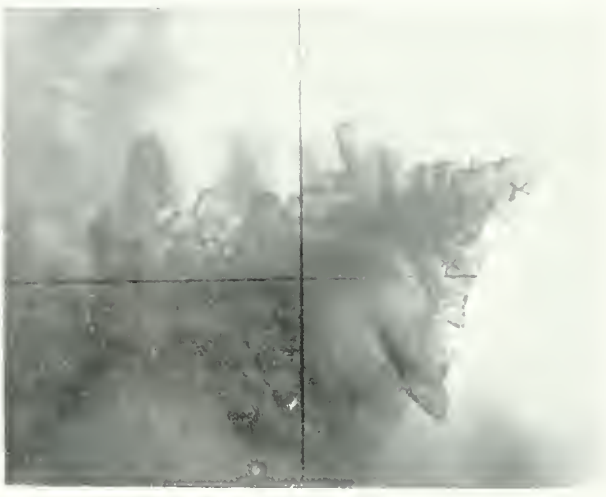


Figure 2.

One of the Crystalline Projections which clasp the drop shown in Figure 1, as seen under the microscope.

That the explanation given above is the true one is supported by the marked difference in the method of growth of the two kinds of stalactites, viz., those formed from bicarbonate of lime and those formed from lime-water. Sir Archibald Geikie, on p. 475 of volume 1 of the new edition of his *Text Book of Geology*, says, in connection with chemical deposits:—

"Of these by far the most abundant is calcium carbonate. The way in which this substance is removed and re-deposited by permeating water can be instinctively studied in the formation of the familiar *stalactites* and *stalagmites* beneath damp arches and in lime-stone caves. As each drop gathers on the roof and begins to evaporate and lose carbonic acid, the excess of carbonate which it can no longer retain is deposited round its edges as a ring. Drop succeeding drop, the original ring grows into a long pendant tube, which, by subsequent deposit inside and outside, becomes a solid stalk, and on reaching the floor may thicken into a massive pillar. At first the calcareous substance is soft, and, when dry, pulverulent, but by prolonged saturation and the internal deposit of calcite it becomes by degrees crystalline."

It is here clearly stated that the original deposit

which goes to form a stalactite (whether in a limestone cave or under a damp arch) is soft and that it only becomes crystalline by degrees, whereas the stalactite formed from lime-water grows by a *method of crystallisation*, as may easily be seen in Figure 2, which is a microphotograph of the growing point of the tube, in which the magnification is about thirty-eight diameters. It somewhat resembles, except in rate of formation, a "frond" of crystalline sal-ammoniac, as seen growing on a glass slide under a microscope, and it is in striking contrast to the soft amorphous deposit of calcium carbonate one so often sees in lime-water. Again, the deposition of the calcium carbonate, which goes to form a stalactite, as stated in the above extract, is due to loss of carbonic acid gas, and takes place at the "base" of the drop; but as may be seen on an examination of the drop in Figure 1, the "claws" of the crystalline growth nearly encircle the drop, and it appears almost as if the extension of this crystalline growth was due to and coïncident with the absorption of the carbonic acid gas of the air by the lime-water: a suggestion which is supported by the fact that the drop of lime-water remains absolutely clear and bright through all the stages of its formation, none of the milkiness usually caused by prolonged exposure to the air being apparent.

It would be strange indeed if the causes of formation of the two kinds of stalactites should be of such an opposite nature, *viz*: in one case the loss, and in the other the absorption, of the carbonic acid gas of the atmosphere, but one seems forced to that conclusion unless, as is just possible, both processes take place in the case of the drop of lime-water, the gas being absorbed in the earlier stages of its formation and lost in the later stages, as the water in the drop evaporates; but if this explanation were the true one, the drop would be milky in the earlier stages of its growth, whereas, as already stated, this does not appear to be the case.

QUERIES AND ANSWERS.

Readers are invited to send in Questions and to answer the Queries which are printed on this page.

QUESTIONS.

2 (page 288), 7 and 8 (page 354) still remain unanswered.

9. DYNAMO AND MOTOR.—A continuous current motor which is to work at a rate of 100 H.-Power is to be driven by energy conveyed by means of a conductor whose resistance is 100 ohms, with a waste of not more than ten per cent. of the energy supplied by the dynamo. What must be the E. M. F. in the dynamo and the back E. M. F. in the motor? How many calories are produced per hour?

ENQUIRER.

10. WATER AND ITS OWN LEVEL.—The subjoined problem was submitted to me by a young friend:—"It is strange that water is said to find its own level, and yet the surface of the world, about two-thirds of which is water, is round."

G. G. B.

11. A BOOK ON WASPS.—I have to thank "Biologist" for the information he gives about wasps; would he further oblige me by referring me to a *really good* book on the natural history of these insects? For the last two years our school children have earned 2d. for each queen wasp killed, besides prizes to the three who have killed the largest numbers; this year they killed over 650, with the result, up to the present, of a sensible diminution of the wasps seen as compared with previous years. I am inclined to think that I have now and then seen other wasps besides queens, in the late spring, and which I presume must have survived the winter.

JOHN GLAS. SANDEMAN.

12. ELECTRIFIED WATER DROPS.—In Professor Boys' "Soap Bubbles," p. 91, Figure 42 shews how the previously scattered drops of a water jet coalesce on the approach of an electrified stick of sealing wax. I can understand that if the sealing wax is held in front of the jet the back half of the front drops would be negatively electrified and the front half of those immediately behind them be positively electrified and that those would thus attract each other. But why should the drops repel each other when the sealing wax is brought nearer? I also do not understand why the former case should explain the large size of drops in a thunderstorm (pp. 99–100). If rain drops fall from a positively electrified thundercloud would they not all have the same sign and thus repel each other?

A. T.

REPLIES.

3. In reply to the question No. 3 in the August issue (page 301) I may say that January, 1907, was marked in Eastern Europe with very great pressures. We have had on sea shore:—

22.1.07—Helsingfors	...	799·0 mm. ...	(=31·46 inch)
.. —St. Petersburg	...	798·8	31·45 ..
.. —Riga	...	799·8	31·49 ..
.. —Vindava	...	799·8	31·49 ..
24.1.07—Odessa	...	794·0	31·24 ..

The figures (in mm.) are taken from *A. Klossovshy* Foundations of Meteorology (Russian) Odessa, Mathesis, 1910].

A. ORLINSKY.

5. In reply to the enquiry of "T.M." in the August number he cannot I think do better than obtain one of *Philips' Planispheres*, which will give what he is wanting for any time on any day throughout the year. It can be set in a moment to any date and time. I have often found it most useful.

WM. L. JEFFERY.

[NOTE.—We hope to republish an old map that gives the details required.—EDS.]

THE FACE OF THE SKY FOR OCTOBER.

By W. SHACKLETON, F.R.A.S., A.R.C.S.

THE SUN.—On the 1st the Sun rises at 6.1 and sets at 5.39; on the 31st he rises at 6.52 and sets at 4.35. Sunspots and faculae may usually be seen on the disc, though of late the spots have been rather small. The granular structure of the surface can be particularly well seen on foggy mornings, as the atmosphere is quiet and the image steady. The positions of the Sun's axis, centre of the disc, and heliographic longitude of the centre are given in the following table:—

Date.	Axis inclined from N. point.	Centre N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Oct. 3 ...	26° 14′E	6° 34′	40° 52′
,, 8 ...	26° 25′E	6° 17′	334° 55′
,, 13 ...	26° 25′E	5° 57′	268° 57′
,, 18 ...	26° 14′E	5° 34′	202° 59′
,, 23 ...	25° 51′E	5° 9′	137° 3′
,, 28 ...	25° 17′E	4° 41′	71° 7′
Nov. 2 ...	24° 31′E	4° 11′	5° 11′
,, 7 ...	23° 32′E	3° 30′	299° 16′

THE MOON:—

Date.	Phases.	H. M.
Oct. 3 ...	● New Moon	8 32 a.m.
,, 11 ...	☽ First Quarter	1 40 p.m.
,, 18 ...	○ Full Moon	2 24 p.m.
,, 25 ...	☾ Last Quarter	5 48 a.m.
Nov. 2 ...	● New Moon	1 56 a.m.
Oct. 7 ...	Apogee	7 12 a.m.
,, 19 ...	Perigee	3 12 a.m.
Nov. 3 ...	Apogee	0 12 a.m.

OCCULTATIONS.—The following table gives particulars of the principal occultations visible from Greenwich.

The second magnitude star δ Scorpii is occulted just before Sunset, but the phenomenon can be observed with telescopes of moderate aperture since the star is bright.

Date.	Star's Name.	Magnitude.	Disappearance.		Reappearance.	
			Mean Time.	Angle from N. point. E.	Mean Time.	Angle from N. point. E.
			p.m.		p.m.	
Oct. 7	δ Scorpii	2·5	5 0	111°	6.23	280°
,, 19	σ Arietis	5·5	8 16	45°	9.12	256°
,, 22	139 Tauri	4·7	8.13	75°	9.3	263°
			a.m.		a.m.	
,, 27	η Leonis	3·6	2.44	103°	3.51	296°

THE PLANETS.—Mercury (Oct. 1st, R.A. $11^h\ 49^m$; Dec. N. 0° 5′. Nov. 1st, R.A. $13^h\ 58^m$; Dec. S. 10° 50′) is a morning star in Virgo, rising on the 15th about 4.30 a.m. or $1^h\ 40^m$ before the Sun. The planet is at greatest westerly elongation of 18° 3′ from the Sun on the 11th. The elongation is moderately favourable for observation except that the planet is only visible in the early morning.

Venus (Oct. 1st, R.A. $11^h\ 37^m$; Dec. N. 4° 2′. Nov. 1st, R.A. $14^h\ 1^m$; Dec. S. 11° 5′) is a morning star in Virgo, rising at 5.20 a.m. on the 15th. The planet is practically invisible as she will shortly be in superior conjunction with the Sun. The planet is in conjunction with Mercury on the 3rd.

Mars (Oct. 1st, R.A. $12^h\ 24^m$; Dec. S. 1° 43′; Nov. 1st, R.A. $13^h\ 40^m$; Dec. S. 9° 44′) is out of range for observation as he was in conjunction with the Sun on the 27th of last month.

Jupiter (Oct. 1st, R.A. $13^h\ 20^m$; Dec. S. 7° 14′. Nov. 1st, $13^h\ 45^m$; Dec. S. 9° 42′) is inobservable being in conjunction with the Sun on the 19th.

Saturn (Oct. 1st, R.A. $2^h\ 15^m$; Dec. N. 10° 39′. Nov. 1st, R.A. $2^h\ 6^m$; Dec. N. 9° 50′) attains a greater altitude than he has done for many years and is very favourably placed for observation, since he is in opposition to the Sun on the 27th, and visible throughout the whole night. On the 23rd he is due South at midnight. The planet forms a conspicuous object in the sky looking S.E., being situated about 13° South of α Arietis, where he may be observed shining as a bright star free from scintillation, but with a peculiar lustre which has given it the name of the leaden planet. The telescope view of the planet is superb, and even when other objects are difficult to define Saturn exhibits crisp detail, well repaying observation. The ring is visible in quite small telescopes, such as ordinary good deer stalkers, with a high power eye-piece, and in a good three-inch telescope the ring is visible with a power of about 50, and the belts on the planet's surface with a power of about 80; using higher powers the principal division in the ring may be seen. The diameters of the outer major and minor axes of the ring system are respectively 47″ and 14″, so that the ring appears well open, being inclined to our line of vision at an angle of 17°, the Southern surface being visible. The planet has eight satellites: of these Titan (magnitude 8·5) can be observed with a good objective of two inches aperture. Iapetus (magnitude 9–12) may be seen at westerly elongation (Oct. 15th) with a telescope of three inches aperture, which is also sufficient to show Rhea (magnitude 9·5) and Tethys (magnitude 10), whilst Dione (magnitude 10·5) requires an aperture of four inches.

The three other satellites require larger telescopes since their magnitude is less than 12.

Ceres (Oct. 1st. R.A. $1^h\ 29^m$; Dec. S. 6° 31′. Oct. 31st R.A. $1^h\ 4^m$; Dec. S. 7° 53′) is in opposition to the Sun on the 9th; the asteroid then appears at its brighest, the magnitude being 7·5, and is thus visible in very small telescopes. The minor planet is situated about 1° N. of θ Ceti. Ceres is probably the largest of the minor planets but its reflective power is less than Vesta, hence it is somewhat fainter.

Uranus (Oct. 15th, R.A. $19^h\ 33^m$; Dec. S. 22° 15′) remains in Sagittarius but is rather low down and sets about 10 p.m. near the middle of the month. The planet is situated in a part of the sky devoid of good reference stars, though the 4th magnitude star h Sagittarii is about 2° to the South. The planet is in quadrature on the 15th.

Neptune (Oct. 15th, R.A. $7^h\ 33^m$; Dec. N. 21° 6′) rises shortly after 10 p.m. and crosses the meridian at 6 a.m. at the middle of the month. The planet is situated about four-and-a-half degrees South-East of the star δ Geminorum, is in quadrature on the 15th and stationary on the 25th.

METEORS.—The principal meteor shower during the month is that having its radiant point near ν Orionis, and hence known as the Orionids. The maximum is from the 18th to the 20th, and the meteors are described as swift with streaks. The radiant point is in R.A. $6^h\ 8^m$, Dec. N. 15°.

Algol presents conveniently observable minima on the 10th at 11.7 p.m., the 13th at 7.56 p.m. and on Nov. 2nd at 9.38 p.m. The period is $2^d\ 20^h\ 49^m$, from which other minima may be calculated.

TELESCOPIC OBJECTS:—

DOUBLE STARS.—γ Arietis $1^h\ 48^m$, N. 18° 48′, magnitudes 4·2, 4·4; separation, 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedae $1^h\ 58^m$, N. 41° 54′, magnitudes 2·1, 4·9; separation 10″. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a Binary, the components of which are now less than 1″ apart.

NEBULAE.—Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedae. Seen with a three or four inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2° to the South. It is fairly round, and appears somewhat like a star out of focus.

(18 $\frac{M}{8}$) lies about the same distance North of the great Andromeda nebula that 32 M does South; it is faint, but large and elliptical.

THE OCTOBER METEORIC SHOWER.

By W. F. DENNING, F.R.A.S.

OCTOBER, like August and November, has its special meteoric shower, and it is a very interesting one, though not distinguished by any known cometary relations. It returns every year, and furnishes many of the meteors presented in our skies between about October 10th and 25th. The radiant point is on the North-Eastern boundary of Orion, in 92° + 15°, and it rises at about $8^h\ 54^m$ on the 21st.

Observations of this shower are not possible, therefore, before 9 p.m., and are best conducted in the morning hours, when the radiant has attained a good elevation. I have often found meteors surprisingly abundant after midnight on about October 15–20. In certain years, and especially in 1877, they appeared in such plentiful numbers that I could only record a portion of those visible.

The Orionids are very similar in their visible aspects to the Perseids of August, but the radiant points of the two streams apparently present a marked difference of feature. While the Perseid radiant exhibits a nightly displacement, the Orionid centre remains stationary at one and the same position. I have investigated this peculiarity to the best of my means, and have always failed to recognise any traces of motion in the Orionid radiant.

It would be well if other observers gave attention to this circumstance and derived the place of radiation for each night from October 15th to 25th, but this would require that the sky be watched all or nearly all through the long October nights, as the shower is not very rich except on about October 19th and 20th, when the maximum occurs.

Another curious fact requiring notice is that in recent years the focus of emanation appears to have shifted, or that a new shower has supplanted the old one. During the last ten years or so I have found the principal display directed from about 8 degrees east of the position it occupied in former years. In fact recent showers have come from near ξ Geminorum instead of ν Orionis, the radiant being at 100° + 13° instead of at 92°+15°. This came out prominently from my observations and it remains to be seen whether the alteration of radiant is maintained in future years.

Perhaps there are two active displays at the points above-mentioned, and they may alternately assume predominance. The question is a very interesting one and deserves full attention. The easterly radiant in Gemini was well seen by Miss Herschel and by Mr. T. W. Backhouse in 1871, and by myself in 1877 and 1879.

This year moonlight will be practically absent from the nocturnal sky and afford an excellent opportunity for observers. But something else is needed, and that is a clear atmosphere. If this favours us during the third and fourth weeks of October, a very successful series of observations may be obtained. At this particular season the firmament is rich in meteors and the observer will find that he must be very expeditious if he desires to register all the meteors presented before him.

In the English climate it is unfortunate that our autumn nights are often overcast, and the probability is that at the important epoch for the meteors the sky will be at least partially clouded. The only thing for intending observers to do is to make the best use of such opportunities as may be presented. Some of the nights intervening between October 10th and 25th will certainly be clear, and the sky should then be attentively watched for the swift, streaking meteors from Orion–Gemini.

What cannot be accomplished in one year can be done by amalgamating the results of many years. In deducing facts from my own observations I have frequently had to collect and compare materials spreading over a series of years. This has often been really essential owing to the serious breaks in individual years occasioned by moonlight and cloudy weather.

The heights of the October meteors are nearly the same as those of the August meteors, the average values at beginning and ending of the visible flights being from about 80 to 50 miles. But only a few members of the October shower seem to have been doubly observed and to have had their real paths calculated.

For the purpose of securing the desirable materials observers should watch the sky on systematic lines and record all the pretty bright meteors they notice. If the hours of from 10 to 12 p.m. were selected for simultaneous observations between October 15th and 25th on clear nights, it is probable we should get a considerable number of valuable materials. Let the observers in the S.E. of England direct their watch towards the Western sky, while the observers in the S.W. look Eastwards, and those in the Northern Counties give attention to the Southern heavens. In this manner meteors appearing over the central part of the country will be seen by two or three of the persons engaged.

It is to be hoped that some scheme of coöperation such as this will be adopted, as the results promise to be far more valuable than those accruing from independent efforts. Every observer fortunate enough to witness the descent of bright meteors should report particulars to those working at this branch.

CORRESPONDENCE.

THE PLUMAGE TRADE IN CHINA.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. Buckland's scathing attack on the iniquities of the plumage trade, in his address before the Selborne Society, has drawn a reply from the Feather Dealers denying the extinction of the Heron in China. As a nature lover, and one who has lived and travelled much in China, I am impelled by the request in the August number of "KNOWLEDGE" to give the benefit of my experience, in the hope that it may be of some interest upon the points at present under discussion.

In the first place it would be just as well to point out that there are few, if any, districts in China that could be termed inaccessible. The enormous population of the Chinese Empire, and the tremendous struggle for existence that perpetually goes on among its teeming millions of industrious people, makes it a stern necessity to utilise every bit of land possible for food production, no matter how poor and unproductive it may be. One of the most impressive sights in the mountainous districts of West China is the marvellous manner in which the most unlikely places are turned to good account in this way. As you sail through the gorges of the upper Yang-tsze you are amazed to see little homesteads perched away up on seemingly inaccessible heights, surrounded by little patches of growing crops here and there; in fact, wherever the slope is not too steep to retain the soil, there you will find something useful cultivated. Consequently, wherever you go in China you can never get away from human habitations. There are no great forests or dreary wastes, and, while some districts are more sparsely populated than others, the general rule is that every bit of land is needed for the support of an immense population. The suggestion of the feather traders that the birds had retired to "less accessible" districts, betrays, therefore, the most absolute ignorance of China and the Chinese. In fact, no such places as are implied by the traders exist in the Chinese Empire any nearer than the Central Asian deserts.

Mr. Buckland is not quite correct in stating that the "molestation did not come from the inhabitants of China." In some parts of China, at least, they are not altogether despised as food. I cannot speak from personal experience upon this point, as I have never myself seen any herons exposed for sale or used for food. Dr. Wells Williams (a most reliable authority), however, in his History of the Middle Kingdom, vol. i, page 339, gives a very horrible account of the cruelty practised upon Egrets exposed for sale in the markets of Canton, to which I would refer those who desire further information upon this point. Only, it is well to remember that the tastes of the Cantonese, gastronomically and otherwise, differ widely from the majority of the inhabitants of China. For instance, most people believe that all Chinese eat dogs; as a matter of fact, however, this habit is almost entirely confined to Canton, so that it is not safe to judge the whole of China by the customs of one city, or even of one province. I am therefore certain that outside of Canton the White Heron is universally discarded as food. The Chinese, too, are not altogether free from blame in the matter of the nefarious plumage trade, and while the European exporters in Shanghai are mainly responsible for this horrible business, yet, the actual killing off of the birds has been done by the Chinese themselves. This is hardly to be wondered at, if we consider the extreme poverty of the people, and the—to them—fabulous prices paid for plumes. How the trade is worked is mainly in this way. China, for a considerable number of years past, has been over-run by native agents of European firms, buying bristles, feathers, down, hides, and so on, and these buyers have been the principal instruments of destruction in this shameful plumage traffic. While representing highly reputable merchants in the Treaty Ports, who would, of course, disdain to have anything to do with such a trade, they have at the same time been acting on behalf of the plumage exporters, and as there is good money to be made out of it no efforts were spared by them, wherever they went, to procure these beautiful adornments of the Osprey. The knowledge that high prices could be obtained for these things was thus disseminated far and wide, and led, of course, to poor people everywhere adding to their meagre income by hunting for the greatly desired and highly valuable plumes. In consequence of this almost universal war upon the heronries these beautiful birds have now been practically exterminated in many parts of China, where hitherto they were fairly plentiful. It is impossible for me to speak definitely about the whole of China, but what I have said certainly applies to the great region of the Yang-tsze Valley, and, from my own observations and from what I have heard first hand from Chinese, I am inclined to believe that Mr. Buckland is not *very far wrong in asserting that the Heron has practically disappeared from China.*

During my residence in the West of China I knew intimately many of these roaming representatives of European commerce that I have described, and all of them have many a time complained to me of the increasing difficulty of obtaining a supply of plumes, due entirely, of course, to the disappearance of the Heron from former prolific sources of supply. If any further proof was needed upon this point, surely it is supplied by the stringent prohibition which was placed upon the export of plumes by the Chinese Government some ten years ago. That the exportation still goes on is, unfortunately, only too true, and the Chinese Government have the misfortune to be too powerless in the matter of this clandestine and illegal business—as in other things where foreigners are concerned—to deal with it effectually. To those who do not know China, it is impossible to conceive how difficult it is for the Chinese Government to enforce anything for the good of their own people or country, if it should happen to conflict with the interests of the foreigners. The law of ex-territoriality, too, makes the European commercial intriguer all supreme, and, notwithstanding the fact that all intelligent Chinese are against such a wicked despoliation of their country, yet they are practically helpless in their well-meant efforts to suppress it.

It is perhaps too much to expect any genuine support being given by our own country to the beneficent efforts of the Chinese to save this beautiful bird from extinction. A nation that for the sake of commercial gain can look calmly and serenely upon the awful spectacle of the destruction of the souls and bodies of countless millions of Chinese, by forcing upon them our accursed Indian opium, is not likely to be moved to much sympathy with this most righteous bird-preservation propaganda by any consideration, either aesthetic, moral, or human. In fact our national conscience seems to be dead; past all hope of resurrection. One thing is certain; unless we begin by helping ourselves we shall never to able to help anybody else. We could not, therefore, make a better beginning in this direction than by *stopping the importation of these plumes into our own country.* A sweeping and comprehensive Act of Parliament to enforce this, and to deal effectually with the present critical state of affairs in the world of Nature, is the crying need of the hour.

W.H.

NOTES.

ASTRONOMY.

"GREENWICH OBSERVATIONS."—The change in the Astronomers Royal brought about by the efflux of time affords an excellent opportunity for the remodelling of the annual publication, *Greenwich Observations*.

In offering our hearty good wishes and a long reign to the Astronomer Royal, Mr. F. W. Dyson, who is returning to his former home, we express our appreciation of the good work achieved by Sir William Christie since 1882, and of the enormous amount of labour that has been accomplished in the reorganization—practically rebuilding—of the Observatory; this work has been accomplished only by the hearty coöperation of the assistants and computers—and upon the latter falls the brunt of the work—and by the support of the Visitors, the Admiralty, and the Public Funds.

The annual volume, published fairly up to date for such a huge tome, bears testimony to the large amount of work which is entailed in the constant preparation of the manuscript and reading the proof sheets. From a personal acquaintance with these volumes we venture to suggest to the new Astronomer Royal that, now the Observatory has been remodelled, he should remodel this annual publication, which has been continued now for seventy years without apparent change (save the incorporation of new subjects) in the profuseness and redundancy of details.

In volumes taken at random we find the following:—"Introduction," in 1843, 86 pages; 1851, 89 pages; 1855, 113 pages; 1865, 102 pages and 57 pages (meteorological); 1874, 131+67 pages; 1883, 112+52 pages; 1891, 153+60 pages; 1898, 128+64 pages; and in 1907, 140+59 pages. A very large percentage of the information contained in these introductions is constant from year to year, and the incessant annual repetition is absolutely needless, a waste of time to prepare and read the proofs, a waste of library space, and, what is worse, a sheer waste of public money in printing. If full details were printed in every tenth volume, such as for those years ending with a nought, and the essential changes were only printed annually, fully one hundred of those pages might be spared and reference made to the tenth-year volumes: the volumes would be about half-an-inch thinner annually. Then as to the printing of the separate observations in R.A. and N.P.D. *in extenso*. This started in the volumes seventy years ago and has been perpetuated to the last published volume, or to 1907. Whatever may have been the reasons in 1840 for considering it necessary to print the details of each wire and microscope observed, the separate corrections for clock-rates, collimation, runs of screw, refraction details, and so on, in order that anyone might examine each step of the reductions, they are certainly not now creditable nor the details requisite if the printed results are to be taken as accurate reductions. If not, and we fear that by the periodical appearance of from six to twelve pages of *errata* there is some doubt on that point, then why not save the time of the staff and the public expense of printing such details and apply the former to additional examination of the reductions, and then print the results only after full assimilation and digestion; one to two hundred pages might be advantageously saved in this portion of the volume annually; exceptions might be made for observations of the sun and moon. Much economy might be achieved in other sections of the annual volume, either by the rearrangement or by a digest of the observations and materials. We find the various forms of pagination inconvenient in reference, though these forms undoubtedly facilitate the speed of printing. Besides all this, the volumes are much too ponderous and inconvenient to use comfortably; we have known them used as weights, props, chair cushions, hassocks, and even weapons of defence; the last use we have known to be quite effective on some occasions. May we offer these remarks with the best intentions and venture to express a hope that Mr. Dyson will take this matter seriously and rigorously in hand and make the annual volumes of our National Observatory conform more to the needs and requirements of workers, and to the more up-to-date publications of other observatories, at some of which compactness is, however, carried too far. B.

VARIABLE STARS.—A most concise and handy booklet, entitled "*Catalogue des Etoiles Variables pour 1900·0*," has just been distributed. It forms a portion of the "Annuaire," published by the Bureau des Longitudes for 1909.

It is only 6-in. × 3¾-in., and has 62 pages, but in those few and small pages a great deal of information about 1,342 variable stars has been arranged in a clear manner, and four explanatory pages of letterpress precede the tabular arrangement. We may with advantage reprint the important preface: "Le catalogue renferme dans les pages 580–633 de l'Annuaire pour 1909, ne sera pas réimprimé pendant plusieurs années. Pour faciliter l'emploi de nos Tableaux des variables pendant ce temps, où nous ne donnerons que des catalogues supplémentaires, nous joignons à l'Annuaire de 1910 un extrait de ce Catalogue que nous prions de lecteur de conserver jusqu'à l'apparition d'un nouveau catalogue général."

The Chandler and Pickering numbers are given, also the R.A. and Dec. for 1900·0—at last we seem to have got away from the 1855 epoch, which variable stars observers so love—the precessions, the maximum and minimum magnitudes, the type of star, and the constellation name: to the last we object. Of all nations in the world, at least European, we believe that the French alone persist in calling the constellations by the French word rather than by the universally used equivalent in Latin; it is an outrage to one's human nature to have said to one, "beta virgin," "eta whale," or "eta bull."

The booklet weighs about an ounce, and can be put in the proverbial waistcoat pocket. B.

PHOTOGRAPHISCHE STERNKARTEN.—The Star-Charts published and edited by Herr J. Palisa (of the Vienna Observatory) and Dr. Max Wolf (of Heidelberg Observatory) have reached the fourth series. They are very convenient in size—much more so than the International Survey Charts, which are needlessly enlarged from the original plates—though each contains several degrees of the sky and has the coördinates indicated in the direct and inverted positions and includes stars to about the fourteenth magnitude. They can be obtained direct from Herr J. Palisa, at cost price, within four months of publication, and should be found in the working library of all star searchers. B.

BOTANY.

By Professor F. Cavers, D.Sc., F.L.S.

BOTANY AT THE BRITISH ASSOCIATION.—In how far is the present provision for the study of the British Flora sufficient and satisfactory? This question, which was raised and discussed by Professor Trail in his Presidential Address to Section K (Botany) at the Sheffield meeting of the British Association, is of great importance to all earnest students of plant-life, whatever be the special branch of the subject they may have specialised in, as well as to those—and their number is constantly on the increase—who take a general interest in Nature Study and outdoor Botany. Professor Trail pointed out a danger which has probably been recognised for some time back by botanists generally, and more especially by those whose work lies largely in the teaching of this subject. While everyone will agree that the ability to name plants can hardly be regarded as the Alpha and Omega of Botany, there is a real danger that the reaction from the older limitations may lead to an almost equally narrow view of the scope of botanical work. The enormous strides that have been taken in modern times in the elaboration of research methods has given rise to a race of botanists whose waking hours are chiefly spent in the

laboratory, and who are too much disposed to regard work in the field as waste of time. The horizon of the extreme type of "laboratory botanist" is apt to be bounded by the walls of the laboratory itself, and it is time that those responsible for the teaching of Botany in our universities and colleges should do their utmost to discourage the idea that the microscope, the microtome, and the other apparatus of the laboratory, excellent as they are as aids to the knowledge of plant-life, must not be allowed to monopolise the student's attention and to replace thorough study of plants in their habitats. The botanist's equipment is imperfect and one-sided unless field work has throughout his training gone hand in hand with regular outdoor observation all the year round.

Professor Trail devoted a large portion of his address to criticism of the present literature of systematic and geographical Botany in Britain, calling attention to the difficulties which beset the path of those whose tastes lie in the direction of studying plants in the field rather than in the laboratory, and who wish to make as complete acquaintance as possible with the plants of their own neighbourhood. He indicated some of the more serious gaps in the literature of the British Flora —using that term in the widest sense, instead of restricting it to the vascular plants—and concluded with a plea for a well-organised botanical survey of the British Isles.

Space forbids a more detailed consideration here of Professor Trail's valuable address. Notes are appended with regard to some of the papers read in the Botanical Section.

Professor Bower ("On two Synthetic Genera of Filicales") dealt with two Fern types which on reinvestigation showed structural characters of great importance in connexion with the evolution of Ferns (Filicales) and necessitating their removal from the systematic position which they have hitherto held within this group. As is well known, Professor Bower's previous work has largely contributed to the establishment of a more natural classification of the Ferns and of the whole class of Ferns and Fern-allies (Pteridophyta). He has shown that the Ferns themselves fall into three series—Simplices, Gradatae, and Mixtae—according to whether the sporangia in each sorus arise simultaneously, in basipetal succession, or in no recognisable order; the three series are further characterised by a progressive diminution in the number of spores produced by each sporangium, and by various other well-marked features. Of the two Ferns specially dealt with as "synthetic" genera—linking up forms belonging to the three series just mentioned—*Plagiogyria* was previously classed with *Lomaria* among the Mixtae, but in various respects (stem structure, simple leaf-veining, absence of indusium, sporangium with thick stalk and indeterminate stomium, and so on) it shows resemblances to certain Simplices, especially to the Schizaeaceae, while its "mixed" sorus relates it to the Pterideae among the Mixtae. It is suggested that *Plagiogyria* represents a transitional form from the simple to the mixed sorus, indicating that this step may have occurred without the intervention of a gradate condition. A second and somewhat similar sequence, leading, however, to the gradate series, starts from the second synthetic genus, *Lophosoria*, a Tree-Fern formerly merged in the genus *Alsophila*, belonging to the Cyatheaceae among the Gradatae. Here the sorus is of the simple type, but though this genus resembles the Gleicheniaceae in many respects, the sporangium dehisces laterally instead of vertically, and it is suggested that *Lophosoria* indicates the beginning of a line of evolution which started from the Gleicheniaceae and led to the Gradatae. By the help of these two synthetic genera, *Plagiogyria* and *Lophosoria*, it is possible to trace the origin of two great sequences, or evolutionary series, of Ferns, along lines more or less parallel but distinct—the one leading to the Pterideae section of the Mixtae, the other to the Cyatheaceous type of Gradatae, and it would appear that both may have arisen from types of the Simplices having affinities with the Schizaeaceae and Gleicheniaceae. In working out the morphology of these two interesting genera, Professor Bower has made an important contribution towards the completion of his great classification of the Ferns on a sound and natural basis.

Dr. Kidston and Prof. Gwynne-Vaughan, in a paper on the fossil Fern genus *Tempskya*, described some specially well-preserved Russian specimens which show that these fossils consist of aggregates of branching fern stems imbedded in a compact mass of their own interwoven adventitious roots. The "false stems" thus produced no doubt grew erect as columnar or conical structures about nine feet high, the individual stems being only about the thickness of a slate pencil. Strangely enough, though growing erect, the plant shows well-marked dorsiventral symmetry, having all the leaves on one side of the stem and the roots on the other. The existence of a Fern with this peculiar habit of growth suggests that the strong erect arboreal stems of the modern Tree-Ferns may not be a primitive feature of the order, and these plants may have been derived from forms with a *Tempskya*-like habit, in which the original axis has so greatly surpassed its branches in size and importance that the latter are now almost entirely suppressed, with the result that we have now in the Tree-Ferns of to-day a single main axis strong enough to grow erect without the additional support of a mantle of roots.

As regards the Gymnosperms, we may note an interesting paper by Mr. M. G. Thoday on the ovule of *Gnetum africanum*. In the young ovule the three coverings arise together at the base of the nucellus, the greater portion of the latter standing free in the centre of the ovule. During later development the region between the two inner coverings becomes more and more stretched, so that the innermost covering arises near the apex of the nucellus, and the free portion of the nucellus in the mature seed is very small in proportion to the part developed by intercalary growth. The outer covering resembles the bracts in structure, and is regarded as an extra covering, while the two inner are called integuments and compared with the two integuments in *Welwitschia*. The middle covering (outer integument) has well-developed vascular bundles, while those of the inner are feebly developed. A large pollen-chamber is present in the young ovule. The radial structure of the seed, the presence of a pollen-chamber, and other characters mark Gnetum off very sharply from *Welwitschia*, and probably point to the more primitive nature of the *Gnetum* ovule. The two integuments in both seeds are compared with those of *Lagenostoma* (the seed of *Lyginodendron*, one of the remarkable "Pteridosperms" which form a connecting-link between Ferns and Gymnosperms), the vascular supply of the inner integument having suffered great reduction.

Of the remaining papers here noted, the majority dealt with physiological topics. Dr. F. Darwin described a new method of observing stomata, by means of an instrument devised by him and named the "Porometer." The apparatus consists of a small glass chamber which is cemented on to the stomatal surface of a leaf and connected with a suction-tube and manometer. By diminishing the air-pressure within the chamber, an air-current is made to flow from the leaf through the stomata into the chamber, the diminished pressure in the intercellular spaces leading in the same way to a flow from the external air into the leaf. In practice it is found that the rate of air-flow is strikingly under the influence of the conditions which are known to affect the aperture of the stomata. Thus at night the rate diminishes greatly, and the same effect can be produced by artificial darkness or by severing the stalk and allowing the leaf to wither. When the rate of air-flow is compared with the loss of weight by transpiration, it is found that the two curves rise and fall together, but the Porometer readings have a much greater range than the record of transpiration. It is found, however, that when the Porometer curve is constructed from the *square roots* of the rates of flow, it is roughly parallel to the curve of loss of weight. This is what we should expect, for Dr. H. Brown has shown that diffusion through a plate pierced by small apertures is proportional to their *linear* dimensions, while on the other hand the flow of air through such a plate must vary as the *area* of the holes.

Mr. S. Mangham described some results of his reinvestigation of the paths taken by sugars during translocation from the leaves of green plants. Haberlandt and Schimper concluded, from their anatomical and microchemical researches,

that the sugars travel in the bundle-sheaths of the leaf veins; but Czapek suggested that while diffusion goes on in all living parenchyma cells, yet from rapid translocation over long distances the sieve-tubes furnish the sole paths for the products of assimilation as a whole. Czapek and Schimper used Fehling's solution as a test for reducing sugars, but this method is open to objections—the reagent is reduced by organic substances other than sugars present in the plant, a good deal of diffusion of cell-contents goes on in the hot solution, and the small grains of copper oxide precipitated are not always easy to observe. A much better sugar test—the precipitation of osazones—was used by Thoday, who found that the sieve-tubes provided the main paths for the removal of free sugars from the leaf. This interesting line of work is still in progress, and the results already obtained by Thoday promise a large accession to our knowledge of the movements and changes undergone by carbohydrates in the plant.

Mr. A. S. Horne, in a paper on the absorption of water by certain Leguminous seeds, after dealing with some features in the structure of the seed-coats, gave some interesting results of experiments carried out with the assistance of Miss Coull and Mr. Holzapfel. The weights and volumes of swelling seeds were determined at short intervals for continuous periods of twenty-four hours or more, and the behaviour of each seed represented by a curve. The curves obtained for submerged seeds with sealed micropyle, in the case of broad bean for instance, differ considerably from the curves for unsealed seeds; but it is contended that the use of the micropyle for the admission of water would probably not occur in nature—in every case, at any rate, directly the seed began to absorb, water entered continuously through the seed-coat. Distinctive curve-forms were obtained for different varieties of lupin and for Mendelian peas (*e.g.*, round and wrinkled peas, "bean" pea, "express" pea). It was found that the seed-coat in each case (broad bean, runner, kidney bean, and so on), behaved as a semi-permeable membrane, like the coats of barley, and so on. The coat of the white kidney bean gave remarkable results, the column of liquid rising in the tube of the osmometer in three days to a higher level than it did in the case of pig's bladder membrane in seven or eight days under similar conditions.

Professor Bottomley described his investigations on the association of nitrogen-fixing bacteria with the Blue-green Algae (*Nostoc*, *Anabaena*) found inhabiting the roots of *Cycas*, the thallus of the liverwort *Anthoceros*, and the leaves of the Water-Fern *Azolla*. Cultures made by inoculating nutrient gelatine with drops of crushed *Azolla* leaves or *Anthoceros* thallus gave in two days the typical round colonies of *Azotobacter* and the ovoid colonies of *Pseudomonas*, and these two nitrogen-fixing bacteria were also recognised by staining microtome sections of the plants inhabited by them and by the Algae. It is possible that the association is advantageous to the host plant—the Alga supplying the necessary carbohydrate for the nitrogen-fixing bacteria, and the host plant absorbing some of the nitrogenous product made by the bacteria.

Two papers on the physiology of Fungi may be noted. (1) Professor Buller dealt with the large club-shaped cells (cystidia) found between the spore-producing organs (basidia) in the gills of the toadstool genus *Coprinus*. Brefeld had suggested that the use of the cystidia is to act as props to keep the gills from pressing against each other, and this view is supported by Buller, who adds that the cystidia also serve to provide sufficient space between the gills for the free escape of the spores. The fate of the cystidia is curious—directly they have fulfilled the function of propping the gills apart and keeping the way clear for the falling of the spores from the cap of the toadstool, they undergo self-digestion, their contents being absorbed by the neighbouring cells, and this digestion of the cystidia always occurs before the same fate overtakes the rest of the tissue of the gills. (2) Mr. Leehmere described a species of *Saprolegnia*, one of the aquatic Fungi, which had been kept in cultures but had not formed sexual organs and was therefore not named. The cultures were of interest because of the great variety of methods of asexual reproduction observed under different conditions—this one plant showed methods of asexual reproduction which were regarded by earlier observers as characteristics of six different genera of the family Saprolegniaceae!

Of the ecological papers read, perhaps that of most general interest was Mr. M. Wilson's account of plant distribution in the woods of north-east Kent. In this district a large proportion of the woods is coppice with standards, felling taking place about every fourteen years. There is little variation in the altitude, and the plant distribution depends chiefly on the character of the soil. Five types are distinguished:—(1) Beech type on the shallow soils of the Chalk; standards chiefly beech, undershrubs yew, oak, hazel, dogwood, spindle, and privet; dog's mercury (*Mercurialis perennis*), wood spurge, woolly mullein, and *Viola hirta* are abundant. (2) Ash-hazel type on the "clay with flints" on the Chalk; horn-beam, often found; oak standards usually present; mercury abundant, with primrose and bluebell. (3) Chestnut type on the Thanet Sand; usually coppice with chestnut or oak standards; bramble often present; on the deeper deposits bluebell abundant, with red campion and moschatel; woodruff and goldenrod characteristic of this type. (4) Oak-birch-heather type on the Woolwich and Reading Series and on the Oldhaven Pebble-beds; Scots pine frequently found; woods usually thin and open; heather and bracken abundant, with hairy woodrush and sheep's sorrel; soil usually strongly acid. (5) Oak type on the London Clay; usually coppice with oak standards; bracken abundant, and many plants found in woods of the preceding type occur. There is usually a sharp distinction between the woods occurring on calcareous soils and those on the Tertiary formations; in the former the soil acidity is slight or none, and dog's mercury is abundant, while in the latter the soil is acid, and mercury is absent. Woods of intermediate character are found on alluvial deposits and on the edges of Tertiary deposits. During the latter years of coppice growth a deep shade is produced and few herbaceous plants occur—including plants little affected by shade and flowering in spring, and dwarf plants persisting in the vegetative state and rarely flowering. During this period there is an increase in the amount of humus and probably a simultaneous increase in acidity. Felling causes a great increase in the light intensity, and the temperature of the surface soil increases, these changes resulting in a great increase in the number of herbaceous plants, including (*a*) plants which have persisted during the shade period, and many of which now develop luxuriantly, (*b*) woodland plants unable to exist in the shade period; these are largely biennial, but a few annuals and perennials are found. The maximum development of herbaceous plants is reached during the third year; after this they gradually diminish, on account of the increase of shade, and the shade condition of the vegetation is reached by about the tenth year.

CHEMISTRY.

By C. Ainsworth Mitchell, B.A. (Oxon)., F.I.C.

THE SERUM TEST FOR BLOOD.—Everyone who has read the account of a recent trial for murder must have been struck by the report of the evidence that certain stains had been proved to be human blood by a "new serum test."

As this test, now used for the first time in an English criminal case, is an application of one of the most remarkable discoveries in physiological chemistry, an outline of the principle upon which it is based will doubtless interest even those who have no knowledge of the science.

The discovery dates back to 1898, when Bordet found that the serum from rabbits into which cow's milk had been injected gave a precipitate of casein when added to milk.

Two years later it was shown by Wassermann and Fisch that the use of the precipitating agents formed in the sera of animals, to which substances he gave the name of precipitines, rendered it possible to distinguish between the milk of different kinds of animals, the milk in each instance only yielding a precipitate with the serum specifically adapted to it.

A further extension of the method was discovered in 1902 by von Rigler (*Oesterr. Chem. Zeit*, 1902, 5, 97), who showed

that the flesh of different kinds of animals could thus be differentiated.

For instance, a 20 per cent. aqueous extract of the flesh of a horse was injected into rabbits, which were then killed after a month. The clear filtered serum from the treated rabbit now gave a precipitate with an extract of horse's flesh, but not with that of any other animal. In like manner the serum of a rabbit which had been rendered specific by treatment with an extract of rabbit's flesh, gave a reaction with the extract of the flesh of any other rabbit, but not with that prepared from the flesh of a hare, a cat, or any other animal.

The further application of the method to the examination of blood soon suggested itself, and the process was studied by Dr. de Nobele (*Ann. Chim. Anal.*, 1902, 7, 150), who proved that the serum from a rabbit or mouse into which human serum had been injected gave a precipitate with the serum of human blood, but not with that from the blood of animals.

Even blood stains several months old, when dissolved in a dilute solution of sodium chloride, gave the reaction, though a stain nine years old failed to react. All attempts to prepare a specific serum by feeding the animal with a particular serum instead of by inoculation proved unsuccessful.

It was found that the serum could be evaporated in a vacuum without destroying its activity, and that the dry residue could be kept unaltered for many months and simply re-dissolved when required for use.

Later investigations showed that the test was not so absolutely specific as was first believed, since when a very concentrated solution of blood serum was used, a precipitate was obtained in any case, though it was much smaller in amount than when the blood serum and specific serum corresponded. With a dilution of one part of blood serum in one thousand, however, the tests were always reliable.

The first occasion upon which this test was employed in criminal work was in a trial that took place in France some five years ago. The prisoner had stated that a blood stain had been caused by the blood of a rabbit. A serum specific for rabbit's blood-serum was therefore prepared, and when this gave no precipitate within thirty minutes with an extract from the stain it could be stated with certainty that no rabbit's blood was present.

ACTION OF LEAD ARSENATE ON FOLIAGE.—A recent Bulletin of the U.S. Dept. of Agriculture (No. 131), contains an account by Messrs. Haywood and McDonnell of the effect of lead arsenate upon plants. Preparations of this compound are now extensively used to protect fruit trees against the larvae of the gypsy moth, and, provided no arsenic passes into solution, do not appear to be injurious. Thus in one year the foliage of apple and peach trees was not affected by the treatment, whereas the same substance caused great damage in another year when the atmospheric conditions were more favourable for the decomposition of the lead arsenate. The presence of small quantities of salts in the water used for the dilution had also an influence on the decomposition.

The composition of the commercial preparations varies widely, as does also the product made by any of the published recipes. In any case the arsenic ought not to be present except in complete combination with the lead. An addition of lime to the liquid was found to reduce the tendency to injure the foliage.

ABSORPTION OF IODINE BY SOLID SUBSTANCES.—A considerable amount of iodine may be absorbed by solid substances when exposed to air saturated with iodine vapour, the degree of absorption depending on various conditions, such as the nature and physical condition of the material. The details of an investigation of the phenomenon are published by M. Guichard in the *Comptes Rendus* (1910, Vol. 151, 236), and the following particulars are typical of the results obtained:—Silica, whatever its physical condition, only absorbs an insignificant amount of iodine (not exceeding 0·8 per cent). On the other hand, alumina calcined at various temperatures up to 600° C. takes up amounts varying from 1·8 to 16 per cent., but after being fused absorbs none at all. In like manner calcined magnesia absorbs from 0·4 to 18·9 per cent., the variations depending upon the temperature at which it was calcined and the salt from which it was prepared. The effect of raising the temperature of the calcination is probably to reduce the spaces between the particles, and the cessation of absorption after fusion is probably an indication of the disappearance of these intergranular spaces when the maximum density is reached. The colours of the substances after the absorption vary with the amount of iodine absorbed.

ECONOMIC BIOLOGY.

By Walter E. Collinge, M.Sc., F.L.S., F.E.S.

THE REST PERIOD IN PLANTS.—The winter rest period of plants is a subject of considerable economic importance, and the results of numerous experiments have shown that by different modes of treatment they may be aroused from this resting state or may be caused to omit their ordinary habit of resting and grow continuously.

The latest contribution to the subject is a most interesting memoir by Professor W. L. Howard, of the University of Missouri Agricultural Experiment Station (*Research Bull.*, No. 1, 1910), in which he sets forth the results of a most elaborate investigation upon this subject.

As a result of extensive studies and experimentation he concludes that nearly all fruit trees and ornamental shrubs have definite resting periods, *i.e.*, each species, and possibly each variety, has a certain number of days during which it will not grow under natural conditions. But the great majority of species do not have this winter period of rest so firmly fixed that they cannot be awakened from it. Unfavourable external conditions determine both the time of occurrence and the degree of intensity of the period, and if these unfavourable conditions occur at regular intervals, a plant readily adapts itself to the new demands, and the rest becomes a habit which may continue to be repeated automatically for a longer or shorter period of time.

The Practical Application.—A practical application of the above principles is cited in connection with the peach. This tree is known to have a comparatively short resting period (about six weeks), and is frequently liable to injury in late winter by frost owing to the habit of premature growth during warm days in late winter. If the trees could be caused to continue growing later in the autumn, they would continue dormant a correspondingly longer period in late winter.

Professor Howard concludes "If it were known definitely that plants have a tendency to grow at unseasonable times by reason of the fact that they have very slight resting periods, or that the resting stage is at an end, we might then set about devising means for regulating the period of dormancy, or, knowing that their habits of growth in this respect cannot be easily changed, of finding means for protecting them."

GRAIN WEEVILS.—A correspondent writes requesting some information as to the conditions that favour the breeding and development of grain weevils. Some years ago Mr. F. J. Cole published the results of a series of most interesting experiments (*Journ. Ec. Biol.*, 1906), and more recently I have supplemented these (*Journ. Inst. Brewing*, 1907). The conclusions arrived at as a result of these experiments were, briefly, as follows:—"That moisture, with the appropriate temperature (80 F.) is very favourable to the adult insect; but the same temperature without moisture is fatal. A non-ventilated atmosphere at about 80° F., charged with water vapour (no matter how poor in oxygen, and contaminated with carbolic acid gas), provides the most favourable conditions for the life and reproduction of these insects. They can flourish in a non-ventilated atmosphere, even when containing as much as 80 per cent. of CO_2, if moist. Further, it was shown that they can live in an atmosphere rare in oxygen provided moisture is present.

The conditions under which grain-eating insects live is only very imperfectly known, and careful experiments with such genera as *Tribolium*, *Gnathocerus*, *Tenebrio*, and so on, would on doubt bring to light many points of great biological interest,

OSTRICH FARMING.—In an interesting paper on the possibilities of ostrich farming in the Transvaal (*Trans. Agric. Journ.*, July, 1910), Mr. E. Thornton, the Government Expert, throws out the suggestion of a Government experimental farm, where both good and common birds should be kept, the former to be used for paying the expenses of the farm, and the latter for experimental purposes. One of the advantages of such a farm, he suggests, would be to test the certain poisonous weeds which have proved fatal to cattle and small stock. Standard types of feathers should also be made and loaned to the farmers. There would seem to be great future possibilities in South Africa for such an experimental farm in connection with what is a profitable industry.

GEOLOGY.

By G. W. TYRRELL, A.R.C.S., F.G.S.

THE GEOLOGICAL SURVEY, SCOTLAND.—The Annual Summary of Progress of the Geological Survey for 1909, just issued, contains some interesting matter, especially in regard to Scottish igneous and economic geology. The structure of Ben Nevis is dealt with by Mr. H. B. Maufe in an appendix. The detailed mapping of the district has brought out the fact that the lavas of the summit rest on schists and not on granite. The schists, however, have been almost entirely concealed from view by the uprise of the granite. The latter is shown to be composed of two distinct intrusions, an older porphyritic granite forming an outer ring, and a central plug of fine-grained biotite granite, intrusive in the former, and with a perpendicular junction against the lavas and basement schist. It is shown that the structure in this area admits of a similar interpretation to that of the Glen Coe caldera.

Mr. C. T. Clough has examined the evidence for an unconformity between the Upper Carboniferous Red Barren Measures and the Productive Coal Measures in the West of Scotland, and has come to the important conclusion that it does not justify a stratigraphical break between these formations. Consequently, wherever the Red Barren Measures appear at the surface, the Productive Coal Measures may be expected below them.

THE GEOLOGICAL SURVEY, ENGLAND.—For England and Wales we have the announcements that the survey of the South Wales Coalfield has been completed, and that, in the Nottinghamshire and Derbyshire Field, a junction has been effected with the work on the six-inch scale carried out long ago in Yorkshire by the late Professor Green. We are also informed that the survey of the Southern District (Devon and Cornwall) has been completed as far as contemplated at present. A number of small inliers of Devonian rocks, brought up by folding and faulting, have been found in the Culm Measures to the west of Dartmoor. Interesting observations have also been made on the celebrated granite mass of this area. The general slope of the original upper surface of the granite, as shown by the remains of the sedimentary cover, is very low, varying from twenty-three to thirty-two degrees. This accounts for the fact that the metamorphic aureole attains the great width of nearly four miles in the neighbourhood of Peter Tavy and Mary Tavy.

THE NATURAL CLASSIFICATION OF IGNEOUS ROCKS.—Under this title an important paper by Dr. Whitman Cross appears in the *Quarterly Journal* for August. Dr. Cross is one of the authors of the Quantitative Classification, proposed by four eminent American petrologists some years ago. This system, based on arithmetical relations between the quantities of certain standard minerals into which the analysis of a rock is calculated, is not "natural," in the sense that its divisions are arbitrary and do not coincide with any natural lines of cleavage in the rocks themselves. Dr. Cross contends that a natural classification is improbable, if not impossible, because all the important characters of igneous rocks, the products of complex geological conditions, are more or less gradational—that no natural boundaries between rocks really exist in nature. He passes under review the possibilities of natural classifications based on chemical composition, magmatic differentiation, eutectics, mineral composition, and rock-texture, and finds that no one of these factors gives rise to divisions upon which to base a final petrographic system. A logical classification must therefore be based on the quantitative development of fundamental characters, and the divisions of the scheme must have sharp artificial boundaries. A reply is made to certain criticisms of the Quantitative System which is the outcome of these ideas.

THE BRITISH ASSOCIATION.—Geologists in the British Association this year were fortunate in having as President of the Association such an eminent geologist as Dr. T. G. Bonney. It is necessary to go back eighteen years to the meeting at Edinburgh under the presidency of Sir Archibald Geikie, to find the last time the Association was headed by a geologist. In his Presidential Address Dr. Bonney discussed some aspects of the glacial history of Western Europe, especially in relation to the Alps, upon which, by his extensive travels and researches, he is eminently qualified to speak. One school of glacialists claimed for glaciers a very large share in the sculpture of the Alps. The other school contended that the action of glaciers was abrasive rather than erosive, and that, whilst rock basins might be hollowed out under special circumstances, the sculpture of ridges, crags, and valleys was mainly accomplished by the ordinary agencies of running water and atmospheric denudation, and only slightly modified by the subsequent action of ice. Dr. Bonney made no secret of his preference for the latter view, whilst recognizing the importance of recent work tending to support the rival view of the erosive power of glaciers.

THE BRITISH ASSOCIATION, REPORTS OF GEOLOGICAL COMMITTEES.—The Committee on the Excavation of Critical Sections in the Palaeozoic Rocks of Wales and the West of England report that during 1909 excavations were made in the Cambrian of Comley, Shropshire. A vertical section of the Comley Sandstone Series has now been constructed from the information obtained during the excavations of 1907–1909. In the Report of the Committee on the Faunal Succession in the Lower Carboniferous (Avonian) of the British Isles, Dr. Vaughan describes the results of his correlation of the Dinantian of Belgium with the Avonian of Britain. A brave attempt is made by a Committee, under the chairmanship of Prof. J. W. Gregory, to straighten out the terminological tangle of South African stratigraphy, but as shown in the table of voting (Appendix D), local geologists have by no means arrived at unanimity. The end of the labours of the Committee on the Composition and Origin of the Crystalline Rocks of Anglesey, the fifth report of which is presented, is now within sight. We are promised a map this autumn, and later, a descriptive memoir. The detailed work of Mr. C. I. Gardiner and Prof. S. H. Reynolds on the Silurian Areas of Cos. Mayo and Galway continues. A memoir on the Glensaul area has been published, and work is now proceeding on the rocks of the Kilbride Peninsula (Loch Nafooey area). Much good work seems to have been accomplished by the committees during the past year.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE WEATHER for the week ended August 20th was warm but unsettled. Temperature was above the normal everywhere, but rain was also in excess in all parts except the East and South-East of England, while Sunshine was about the average. Thunderstorms were experienced on the 14th, 15th, and 16th, those of the 15th being widely spread, and strong winds were felt in many places towards the end of the week. While the average temperatures were high, the extremes were not excessive, the highest reported being 79° in Guernsey, but in Scotland N., and in Ireland N., the maximum did not exceed 69°. The lowest shade minimum was 42° at Marlborough.

At Balmoral the lowest recorded was 44°, while in the Channel Islands the lowest was 57°. The lowest temperature on the grass reported was 35° at Sheffield.

At Wick the temperature of the sea water was 54°, while at Margate and at Eastbourne it ranged between 63° and 64°.

At many stations the Rainfall was double the usual amount, but in the E. and S.E. of England it was surprisingly light. Thus at Yarmouth only 0·12 inch was registered, which is less than one-fourth of the average. At Margate only 0·10 inch fell, the average being 0·45 inch.

Scilly reported the most Sunshine, 62·3 hours; the only other stations registering 60 hours or upwards being Falmouth (61·5 hours), and Newquay (60·2 hours).

Unseasonable conditions prevailed during the next week, when it was not only wet, but dull and cold also.

The highest shade temperature reported was 74° at Raunds on the 24th, and at Guernsey on the 25th; while at West Linton, near Edinburgh, the minimum fell to 32° on the 23rd.

On the ground the night minimum fell to 30° at West Linton and to 32° at Sheffield, and to 33° at Birmingham and Newton Rigg. Rainfall was in excess generally, there being but few stations where the amount was not above the average.

At Scilly the total rainfall was 2·26-ins., or almost exactly four times the average. At this station the amount of Bright Sunshine fell to 39·3 hours as against 62·3 hours for the previous week.

The stations reporting most Sunshine were Jersey, 49·3 hours, and Guernsey 47·4 hours, and it is remarkable that the next sunniest station was that furthest to the North, viz: Baltasound in Shetland, with 47·3 hours.

The week ended September 3rd opened with unsettled weather, which, however, improved in the latter part of the week. Thunderstorms were reported on August 29th, 30th, and 31st, and Snow was observed at Raunds on the 28th. Temperature, though differing but little from the average, was generally in defect. The highest reported was only 72°. The maximum for the week in Guernsey was 66°, while at Sumburgh Head in the Shetlands, more than 700 miles further North, 68° was reported.

The lowest shade reading reported was 35°, but on the ground, night frosts were recorded at Newton Rigg, Crathes, and Balmoral.

Rainfall was less than the average in England E., the English Channel and in Ireland, but more elsewhere. The excesses in many cases were large; thus, at Bath 2·98 inches fell, the average for the week being only 0·60 inch.

Bright Sunshine was again in defect nearly everywhere. The highest amounts reported were at Lowestoft (44·1 hours) and Yarmouth (42·8 hours). On the South Coast, Eastbourne had the largest amount (41·7 hours), while in the West no station reported as much as 40 hours, and Newquay had only 28·9 hours.

On August 28th, a kite was sent up by Mr. S. H. R. Salmon, at Brighton, with a meteorograph attached, which attained the height of 5,550 feet. The kite was 7 square metres in area and the length of wire was about 1½ miles. The Humidity which was 88% at ground level fell to 68% at 3,300 feet, but rose again and was 98% at the maximum altitude.

SOUTHPORT METEOROLOGICAL OBSERVATORY.—One of the best equipped of the many meteorological establishments maintained by Local Authorities in the British Islands is that at the Fernley Observatory, where Mr. J. Baxendell, F.R.Met.Soc., for the Southport Corporation, is in charge of a complete outfit of instruments, of which he makes very excellent use.

The Report for 1909 tells of steady and careful work, resulting not only in the accumulation of reliable Statistics of the Climate of the popular Lancashire resort, but also in material that is often of great use in purely scientific investigations.

The frontispiece to the Report is a reproduction of part of the barograph record for December 28–29, 1909, showing a very remarkable series of small oscillations of pressure during the advance of an anti-cyclonic ridge from the Westward.

The Report includes a useful Table of Statistics for 1909 from a large number of Stations, from which it appears that Southport enjoyed 1,611 hours of Bright Sunshine in 1909, as against only 999 hours at Manchester, and 985 hours at Hull.

RAINFALL IN AUSTRALIA.—The Commonwealth of Australia has recently issued two interesting Bulletins which are worthy the attention of many besides those who are directly concerned with agriculture. These Bulletins have been compiled under the direction of Mr. H. A. Hunt, the Commonwealth Meteorologist, who in the first deals with the remarkable flood rains experienced in Victoria in August, 1909, and in the second treats of the monthly distribution of Rainfall over the whole Continent.

The floods referred to accompanied the passage of a deep depression which advanced from the Westward across the South-Eastern parts of Australia, and brought with it very heavy rain which averaged, over a wide area, between 3 inches and 4 inches in less than twenty-four hours.

The river Wimmera has a catchment area of about 1,900 square miles, and it is estimated that nearly 400 millions of tons of rain fell on this land in nineteen hours, giving rise to the heaviest flood that had been known for many years.

The conservation of the Rainfall is one of the most pressing of the problems that confront the Commonwealth Authorities, for not only do floods such as those referred to in this Bulletin cause an immense amount of damage, but the water that runs away is badly wanted later on for irrigation and other industrial purposes.

INTERNATIONAL METEOROLOGICAL COMMITTEE.—A Meeting of the International Meteorological Committee was arranged to be held in Berlin at the end of September. This Committee comprises seventeen members, most of whom are Directors of Meteorological Offices in the various countries they represent. Dr. W. N. Shaw, the Director of the Meteorological Office, London, is Chairman of the Committee, and Professor G. Hellmann, Director of the Prussian Meteorological Service, is Secretary.

The Committee last met in Paris, in 1907, when certain Commissions, or Sub-Committees, were appointed to consider various questions. Two of these Commissions met in London, in June of last year, and their recommendations on the subject of Weather Telegraphy, and of Weather Signalling for Sailors, will come up for consideration, as will also other important questions bearing on various branches of the Science. The Report of the proceedings at the Meeting is sure to be of much interest.

It is somewhat remarkable that since the Paris Meeting the Committee has lost three of its members by death, namely, Professor J. M. Pernter, Director of the Austrian Meteorological Service; Mons. A. Lancaster, Director of the Belgian Meteorological Service; and Sir John Eliot, late Director-General of Indian Observatories.

MICROSCOPY.

By A. W. SHEPPARD, F.R.M.S.,

with the assistance of the following microscopists:—

ARTHUR C. BANFIELD
JAMES BURTON.
THE REV. E. W. BOWELL, M.A.
CHARLES H. CAFFYN.
ARTHUR EARLAND.
RICHARD T. LEWIS, F.R.M.S.
CHAS. F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.Z.S., F.R.M.S.
C. D. SOAR, F.R.M.S

A SIMPLE METHOD OF MAKING DIFFICULT MATERIAL SINK IN FIXATIVES.—It frequently happens to be an extremely difficult matter to cause certain material to sink in the particular fluid required to be used for its fixation. Botanical specimens, such as anthers, spore-bearing leaves of ferns, and similar plant tissue are constantly among this class, as well as lung mucus, and some epithelial tissue of different animals.

Unless able to succeed in keeping such objects totally immersed instead of floating on the surface of the fixing fluid, the fixation is very imperfect and unequal.

In seeking information upon this subject in quite up-to-date books, with a view to help in overcoming such a difficulty, one is often advised by the various authors to make small cuts in different positions and directions with sharp-pointed scissors; others recommend the material to be steeped in alcohol or some other solution for a minute or so before placing in the proper fixative. Workers in histology and cytology are very frequently convinced, on examining their finished preparations and sections, that such methods as these are far from successful, and very often most harmful, especially to small objects. Cutting or snipping certain very small or entire objects causes very distorted appearances when the sections of same are examined under the microscope, especially those not far removed from the cut surfaces. A very noticeable illustration in this direction is the testes of small animals. Here marked swelling in the seminal tubules, and changes in the cells are more or less readily detected in areas some considerable distance from the cut. Testes, however, seldom give any difficulty in sinking in any fluid, but are referred to as an example of the bad effect caused by cutting: whence it is easy to understand that other small material may be affected in a like manner.

Steeping in fluids, such as alcohol, for even so short a time as recommended by some, is far from a good method to adopt. It will be readily understood that here, owing to the highly penetrative action of alcohol, as well as its quick hardening power, you have at least the first five or six external layers of cells alcohol fixed and hardened, so preventing in any marked or required manner the further action and penetration of fixatives possessing such small penetrating power as liquid of Flemming, Lindsay Johnson, or the like.

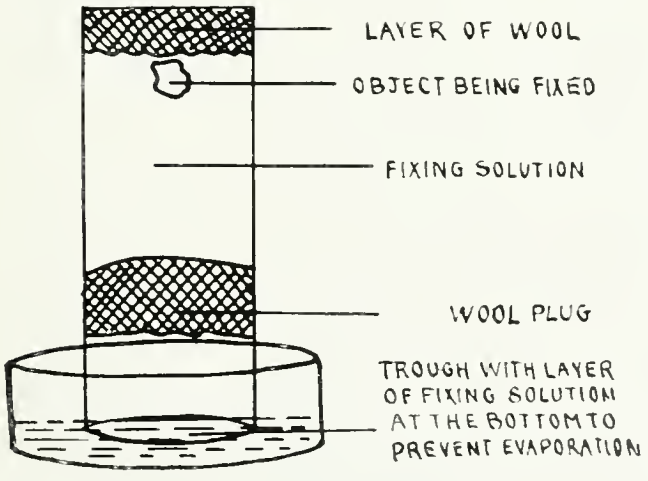
As I have often had to treat material presenting these difficulties, I have many times considered what could be done to overcome this annoyance.

The following, I think, will appeal to many, and is a method that occurred to me, and one that I have used with great success in my laboratory for some time.

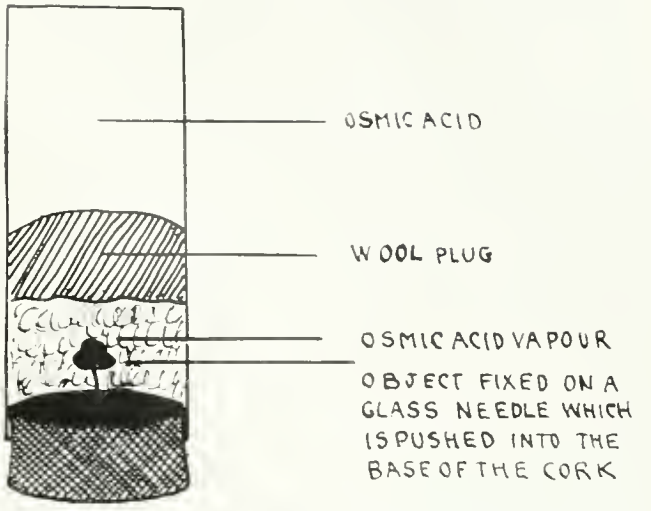
Take cylindrical glass tubes; those used for holding two micro-slips back to back are very useful for the purpose, only it is preferable if they are rather longer than usual; about four inches in height. Of course, when working with fixatives, such as Flemming's strong and Lindsay Johnson's platinum chloride solutions, where a bulk of liquid only four or five times the volume of the object immersed is required, it is not necessary to use such large tubes.

At the bottom of these place a moderately thin layer of clean, long-fibred, absorbent cotton wool. Do not use a cheap wool, as this often contains a lot of short fluffy material, which is annoying and not satisfactory for the purpose.

Now pour into the tube, until it is a little more than two-thirds full, the fixative to be used; then put in your objects to be fixed. Take another piece of wool, and shape or fold in


LAYER OF WOOL
OBJECT BEING FIXED
FIXING SOLUTION
WOOL PLUG
TROUGH WITH LAYER OF FIXING SOLUTION AT THE BOTTOM TO PREVENT EVAPORATION

such a manner that it will require a gentle pressure to push into the tube, and will occupy about an inch in depth; press this down into the tube until it touches the surface of the liquid, and continue the pressure until half the amount of wool is immersed. One or more air spaces will soon be noticed, owing to the absorption of the liquid by the wool;



these can be got rid of by pressing the plug of wool a little further down. Pour a little solution on the top surface of the plug, so as to be sure of complete saturation; pour off what is not absorbed; invert the tube, when the objects will immediately pass to the opposite end and be entirely immersed.

No fear need be entertained about any solution filtering through or down the sides of the plug. To prevent evaporation, gently cork the tube; or the open end can be placed in a glass trough at the bottom of which has been poured a little of the fixative.

Another very useful purpose to which a slight modification of the above may be put is to about half fill the tube with a fluid to the fumes, of which it is wished to expose an object such for example as the vapour of osmic acid. It is not necessary in this case to put a layer of wool at the bottom, but the wool plug must be inserted in exactly the same way as previously described.

On the base of a cork that will fit the tube tightly, place a piece of clean white filter paper, and upon this place the object which you wish to subject to osmic acid vapour; carefully push the cork, with the object upon it, into the inverted tube.

A better method, so as to be sure of all sides of the object coming equally in contact with the fumes, is to push through the middle of the cork a glass needle and upon the point of this carefully press your object.

The second figure will make the procedure quite clear.

E. J. SHEPPARD, F.R.M.S.

SCALES OF HABROSTOLA TRIPLASIA.—This species was not purposely selected as being typical in respect of its scales, but it does happen to possess scales of the leading types. Two of these types are here represented; the figures on the larger scale were made by the help of the 2mm. immersion, the smaller ones with the 16mm. It was found necessary to underexpose the plates; better results may probably be obtained by using monochromatic light and a specially sensitised plate, so as to hold back the background and prevent it from exerting so energetic an action on the film. It was curious to find that the 2mm. required only about twice as long an exposure as the 16mm. The size of the objects may be inferred from the fact that in the broader form of scale here figured the transverse distances from each longitudinal stria to the next, across the middle of the scale, average nearly two micra. The larger or fan-shaped scales, which are in shape somewhat similar to the leaves of *Ginkgo biloba* (a specimen of botanical Latin which I cannot altogether commend), are perhaps typical of the Noctuina. The smaller ones, of an elongate oval shape, are interesting because under a low power they show the "watered silk" appearance. The undulating transverse lines which give rise to this effect may either be due to undulations of the surface of

FIGURE 1. Fan-shaped scales of *Habrostola*, 16 mm.

FIGURE 3. Oval elongate scales of *Habrostola*, showing watered silk appearance, 16 mm.

the scale, or to the irregular disposition of the dots. This appearance may be seen by viewing the more highly magnified figure obliquely. The longitudinal striae, it will be seen, are closer in the elongate oval scales. The dots occur along the striae, and in the interspaces, where they give rise to an appearance of transverse striation, more clearly marked in some other species. There may be a real transverse striation, as well, in which all the lines are not parallel, but seem like a series of I's, while occasionally V's and Y's occur; in such cases there is a dot at the angular junction of the V or Y. The appearances then suggest that the dots are connected by tubules, which appear to be curved, and resemble, on a much smaller scale, the pseudotracheal tubes in a fly's tongue. The real significance of these markings does not seem to be yet understood; but almost all insect scales are probably to be reduced to the same type, so far as their markings are concerned. With regard to the shapes assumed by insect scales and hairs, it would be valuable to have a kind of census made, showing their distribution. Some forms show only one or two types, while others may have six or seven: it may be possible to draw some phylogenetic inferences from the facts, when thoroughly ascertained and tabulated; or, if not, we should have a proof of the independent evolution of similar organs. *Habrostola*, for example, has many scales of a type which is most prevalent in the Vanessidae. The scales of the Zygaenids are as uniform in the individual species as any that I have yet examined; yet related species have, in that tribe, scales of distinct forms. Some sixteen years ago, by the kindness of Mr. J. W. Tutt, I was enabled to examine the scales of a large number of Alpine Zygaenids, with the result just mentioned: a partial report of the matter then appeared in *The Entomologist's Record*. For such a census as I have suggested, it would be advisable to construct a system of nomenclature for the different types of scales, and this should not be done until the number of types and their approximate occurrence is known with greater certainty than at present. One might begin, therefore, by naming the principal known types with letters or figures, to be exchanged afterwards for appropriate and definitory terms. Perhaps some readers of KNOWLEDGE may see their way to assist in this preliminary work; I may mention that my address is 21, Princess-road, South Norwood, S.E. As to the methods of microscopical manipulation of insect scales, I now find it best to make a preliminary examination of the entire insect, fresh if possible, and remove samples of the different scales separately. These are placed for further examination in a minimal quantity of the mounting medium (alcohol and glycerin); I have just found that cedar oil is very good, and it is certainly to be preferred on grounds of optical theory.

E. W. BOWELL.

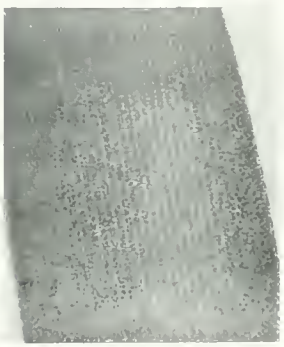


FIGURE 2. Part of a fan-shaped scale of *Habrostola*, 2 mm.

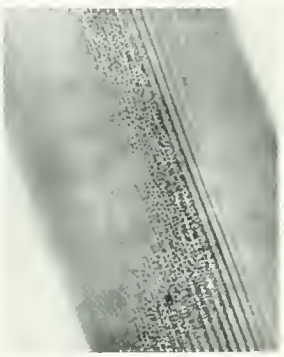


FIGURE 4. Part of an oval elongate scale of *Habrostola*, showing watered silk appearance, 2 mm.

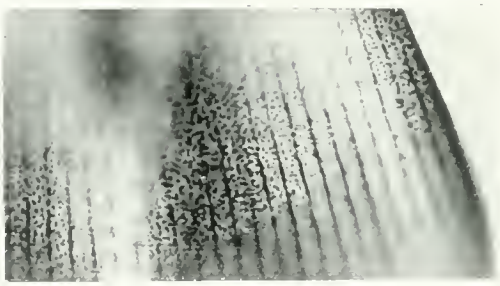


FIGURE 5. Part of another oval elongate scale of *Habrostola* showing watered silk appearance. 2 mm.

FIGURE 6. Scales of *Argynnis*, for comparison.

In some cases, however, it may be necessary to increase the contrast between the structure and its surroundings. It is not very essential to make permanent preparations, but the cedar oil specimens will last indefinitely. Fine results are obtained by the use of the monochromatic system, using ultra-violet rays; Dr. Köhler's figure of the black scale of *Pieris brassicae* (*Zeitschr. f. wiss. Mikrosk. Bd. XXI. Taff. II*) is the finest photograph of the dots and striae that I have yet seen. But with an ordinary microscope the facts may be made out, though it may not be possible to produce such brilliant prints.

Figures 1 to 5 were all taken with the 5 Projection Ocular, and at the same position of the camera.

ON DRAWING MICROSCOPICAL OBJECTS.—The next best thing to a good description of an object, is a good figure of the object described. It prevents many misunderstandings; it saves time in identification; it makes the subject more interesting to the student, and it often causes the casual reader in Natural History subjects to pursue the study further than he would otherwise do.

Many objects can now be figured by means of Photography, and are largely so used in the Journals for the purpose of illustration; but there are some objects, requiring the Microscope to study or see properly, which do not lend themselves to reproduction by means of Photography: they are too thick, and under the Microscope all the points cannot be brought into focus at the same time in consequence much detail is lost. In these cases a drawing is better than a photograph. While making a drawing one can gradually focus down until all details are shown as required. Or the stage of the microscope can be moved to bring parts of the object into view which previously had been outside the field. Many microscopists have an idea that it is very difficult to make a drawing of an object as seen under the microscope; certainly some objects are more difficult than others, but anyone following the simple directions here given cannot fail to make a presentable figure of any object required.

There are several cameras in use for drawing with the microscope; the one used by the writer is Ashe's Camera-lucida, a description of which, and how to use it, is given by Mr. D. J. Scourfield, in the *Journal* of the *Quekett Microscopical Club* (vol. vii, p. 413, 1900). It can be bought at most of the leading dealers in microscopical instruments in London. Its advantage over the old camera-lucida is that the image is not reversed, but can be seen on the paper in the same positions as seen under the microscope; also that the microscope can be left at an angle of say 45° while the drawing is being made, thus doing away with the alteration of the position of the microscope every time it is used with or without the camera. Before commencing, it is necessary to make a few experiments and calculations with the objectives in use by placing an object of known size on the stage; this enables one to give the size of the object and that of the drawing in their true relative proportions; also, when once the magnification is known, to measure up all the detailed work in the drawing. It also enables one to decide which objective to use and how long the draw-tube should be to produce a drawing to a given scale of magnification. By working all this out beforehand much time and trouble is saved. The light through the object and the amount of light on the paper will require nice adjustment, but when this is done satisfactorily and one can see the point of the pencil on the lines of the object, the drawing may be proceeded with, using a hard lead pencil to put in the required lines. These pencilled lines must then be worked over in Indian ink, using a fine etching pen for the purpose; when this is complete the pencil drawing may be cleaned off, leaving the paper with a pen and ink drawing which can now be tinted and shaded up with Indian ink or sepia to the required point of finish. The advantages of the Indian ink being that a wash of colour can be put on without any fear of blurring or disturbing the drawing. Should the drawing require to be finished in colour, make use of coloured waterproof inks as near the colours of the object as possible, and tint and shade with ordinary water colours. There is not much art or practice required: it is simply careful work. The writer is bound to admit that the waterproof inks of various colours are a real boon to the microscopist who wishes to make drawings of his objects in colour. These inks are made and supplied by all artists' colourmen, and they can be mixed to form certain tints at the time of using. Very often the inks are too strong in colour for the purpose required and need diluting; this can always be done by using distilled water to which a drop of liquid ammonia has been added. If ordinary water be used to dilute the inks the colour will not stand washing over.

Chas. D. Soar, F.R.M.S.

PHOTOGRAPHY.

By C. E. Kenneth Mees, D.Sc. (Lond.), F.C.S.

THE USE OF THE PHOTOGRAPHIC PLATE FOR RECORDING AND MEASURING INTENSITIES.—The use of the photographic plate for the recording of position with a view to subsequent measurement has been so general that, in many branches of science, it has entirely superseded direct visual observation. A striking example is supplied by the almost complete disappearance of spectroscopes in favour of spectrographs for all purposes of investigation, though here the new interference methods of wavelength determination are, to some extent, again displacing photography. But the use of the photographic plate for recording the intensity of the light falling upon it is by no means so general, and this for the very good reason that the interpretation of the results is difficult and that, until recently, the relations between the deposit produced and the intensity of the radiation producing it, were somewhat obscure. The use of photography in this way is, however, quite possible if adequate precautions be taken, and, in view of the difficulties involved in all other methods of measuring radiation, and especially such radiation as violet or ultraviolet light, it would seem that for some purposes the photographic method should be of considerable value.

The deposit on a developed and fixed plate consists of almost pure silver. The mass of silver per unit area of the plate can be found by measuring the transparency which it shows for light, and Hurter and Driffield in their original paper on the relations between the mass of silver produced and the exposure and development of the plate, established a useful nomenclature which has been generally accepted.

If I be the light incident on the negative and I_1 the light transmitted then—

$\frac{I_1}{I}$ is termed the Transparency of the plate (T)

and $\frac{I}{I_1}$ or $\frac{1}{T}$ the Opacity (O).

The "extinction coefficient" will therefore be the logarithm of the Opacity or $\log_{10} I - \log_{10} I_1$ and this they termed the Density (D).

The Density of a plate is therefore (from Beer's law) directly proportional to the mass of silver in the plate.

The "photometric constant" or mass of silver in grams per square centimetre which corresponds to a Density of unity, that is, to a plate which transmits one-tenth of the incident light, has several times been determined.

It varies somewhat with the kind of plate, but with plates of medium speed developed with a non-staining developer it may be taken as '0001. So that 1 gram of silver can produce a density of 1 over a square metre of photographic plate.

The photometric constant has been proved to be rigidly independent of the Density.

For a given exposure the relation between the Density produced and the time of development is given by an exponential formula—

$$D = C\ (1 - e^{-kt})$$

where k is the velocity constant of development, and C is the

Density which is produced if development is prolonged to the limit.

It will be seen that (for a non-fogging plate) the Density for a given exposure to light reaches a limit. This limit is generally reached in about ten times the usual time of development, that is to say, in about that time further increase in the Density by increase of developing time will be so small that it may be disregarded.

The relation between the Density produced (with a given developing time) and the exposure, is also exponential, but of a far more complex form.

The relation is shown in the figure below.

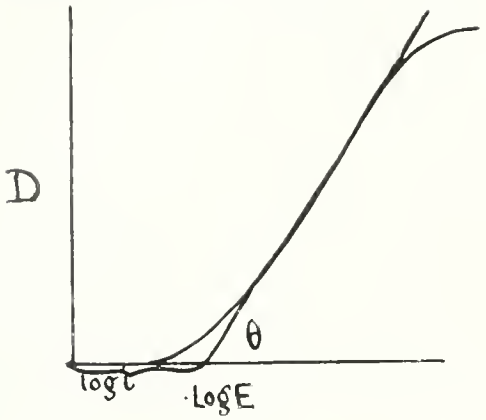


FIGURE 1.

This curve, which, of course, possesses an inflection point, can in practice be divided into three portions.

These portions were termed by Hurter and Driffield:—

(1) "The period of under exposure." Here D increases more rapidly than log. E (for the lower portion, D, is proportional to E).

(2) "The period of correct exposure." Here D is proportional to log. E.

(3) "The period of over exposure." Here D increases less rapidly, and finally reaches a limit (eventually reversing).

We are not now concerned with the properties of this curve as a whole, interesting as that subject is, but only with the "period of correct exposure," because it is only for densities falling within this period that the relations to exposure are sufficiently simple to be trustworthy as a basis for the measurement of intensities.

For this period the relation between D and log. E is approximately linear, and we may write the equation—

$$D = \gamma (\log. E - \log. i) \text{ where } \gamma = \tan \theta.$$

γ was called by Hurter and Driffield the development factor, while i, the exposure corresponding to log. i, was termed the inertia, being taken as a measure of the *insensitiveness* of the plate, the Hurter and Driffield speed number being defined by them as $\frac{34}{i}$.

It is found that for developers without bromide the value of it is unaffected by the time of development, γ increasing proportionally to the Density, so that $\gamma = C(1 - e^{-kt})$ where C is the maximum steepness of gradation which the plate can attain.

It is this maximum steepness of gradation (or γ_∞ as it may be termed) by which the gradation of a plate is defined. Soft working plates have low γ_∞'s (from 1·2 to 1·7), hard working plates high γ_∞'s (from 2·5 to 4·0).

In order, therefore, to find the relation between two intensities of radiation all that is theoretically necessary is to measure the densities produced on a plate which has been developed to a known γ, or for a known time if k and γ_∞ are known.

Practically, however, there would be too much uncertainty introduced if measurements were made in that manner, and the following example will explain the method of procedure in practice. It was desired to measure the relative intensity of the Sodium lines D_1 and D_2 in a number of light sources in order to find whether the ratio was dependent on the source. Arc, flame, spark and vacuum tube spectra were used.

The spectroscope was a reflecting grating Littrow spectrograph of eight feet focal length, the separation for the D lines in the first order being about 1 mm.

The slit was opened until the two lines just touched one another, each being about 1 mm. wide.

Plates were then obtained which were fully sensitive to the spectral region concerned and which were coated on patent plate glass. This is absolutely necessary as the errors introduced by ordinary glass are very considerable. The plates were cut from large plates, the edges being first cut off and thrown away. A colour screen was then prepared which passed only the narrow portion of the spectrum which had the D lines at the centre of it, and this screen was placed in front of an acetylene standard light and some of the plates exposed to this behind a rotating sector wheel so that a series of increasing exposures were impressed upon them. Whenever now a spectrum negative was exposed one of these "sector strip" negatives was developed with it, for the same time, in the same dish.

The Density of the spectral lines and also of the various sectors of the negatives exposed behind the sector wheel to the standard light were measured by means of a photometer, the Density due to glass and gelatine being subtracted, and a curve showing the relation between the Density and logarithmic exposure of the sector strip negative was plotted.

Into this curve were interpolated the Densities of the spectral lines and the corresponding exposures were read off on the abscissa. (Figure 2).

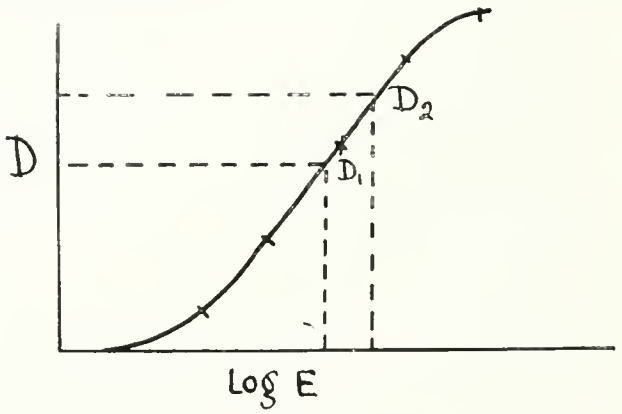


FIGURE 2.

It will be observed that this method avoids all possibility of error in development and also allows for deviation of the curve from a straight line.

The shape of the plate curve depends to some extent upon the wavelength of the light, for which reason the colour screen was employed in exposure.

The result of the measurements made was to show that—

$$\frac{I_{D_2}}{I_{D_1}} = 1{\cdot}41 \text{ and is independent of the source.}$$

The agreement of the measurements made in this way was within 1–2%.

It must be noted, however, that all the precautions given are *necessary*. Mere measurements of Density are not quantitative measurements of intensity unless they are interpolated into a curve produced by known increments of exposure to the same kind of radiation.

PHYSICS.

By W. D. EGGAR, M.A.

SEISMOLOGICAL INVESTIGATIONS.—The fifteenth report of the Committee appointed by the British Association contains much interesting matter. For one thing it appears that more sensitive instruments are wanted. Earthquake tremors are continually passing beneath observatories all over the world without leaving any record, because the apparatus used for detecting the disturbance is too clumsy. Mr. Milne's observatory at Shide, in the Isle of Wight, fitted with the B.A. type of instrument, recorded eight of the after-shocks of the Messina earthquake, of which only two seem to have been recorded at Laibach, Gottingen and Hamburg, which are nearer to the origin than the Isle of Wight, but are fitted with different types of instrument. Between July 1st and Dec. 31st, 1909, Shide Observatory noted two hundred and seventy-nine earthquakes. In the same period Hamburg recorded one hundred and twenty-three, Strassburg sixty-four, and Laibach forty-two. After the earthquake in Jamaica which devastated Kingston in January, 1907, fifty-one of the after-shocks reached Great Britain, the time taken for the tremor to travel from Jamaica, a distance of 67°, being in every case about 43 minutes. This was the first time that small after-shocks had been noticed at places far removed from their epicentral area, and it is remarkable that in each case the British Association type of instrument made the record. It is evident that a high degree of sensitiveness has been attained in this type; and a new field of research has been opened up for which a still more sensitive instrument may ultimately be needed.

BOARD OF TRADE STANDARD OHM.—On January 10th, 1910, His late Majesty King Edward VII. in Council raised the British Standard Ohm through one centigrade degree. The reason for this elevation is as follows. The International Ohm is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area and of a length of 106·300 centimetres. The Board of Trade Standard Ohm was, until the above date, the resistance between the copper terminals of a certain instrument when the coil of insulated wire connected to the aforesaid terminals is in all parts at a temperature of 15·4 C. It had been found, at the last verification of the Standard Ohm, Ampère and Volt, that the Board of Trade standards would agree with the international standards with sufficient precision if only the temperature specified were 16·4 C. instead of 15·4 C. The required degree of accuracy is, for the Ohm, within one hundredth part of one per cent.; for the other standards within one tenth part of one per cent. The change has been made, and is one more step in the direction of international agreement.

ZOOLOGY.

BRITISH ASSOCIATION—PRESIDENT'S ADDRESS IN SECTION D. (ZOOLOGY).—In his presidential address to Section D, Professor G. C. Bourne discussed to begin with the subject of Morphology, which he pointed out is no longer in favour in this country, and among a section of the zoölogical has almost fallen into disgrace. He showed that it deserves the credit of having done well in the past, but if it is to be anything more than a descriptive science, if it is to progress any further in the discovery of the relations of cause and effect, it must alter its methods. Professor Bourne contended that an enquiry into the causes which produce alterations is as much the province of and is as fitly to be called morphology as a discussion of the significance of the patterns of the molar teeth of mammals, or a disputation about the origin of the coelomic cavities of vertebrated or invertebrated animals.

As indicating the kind of work to be done, Professor Bourne alluded to the evidence that is beginning to accumulate which shows that external conditions may produce changes in the germ cells as well as in the body (soma), and that such changes may be specific and of the same kind as similarly produced somatic changes. He further stated that there is evidence that such germinal changes are inherited.

An instance brought forward was the work of Tower upon the Colorado Beetle (*Leptinotarsa decemlineata*) where males and females were subjected to very hot and dry conditions (such as are usually productive of albinic examples) during the maturation and fertilization of the first three batches of eggs. These as soon as laid were removed to normal conditions, but, nevertheless, of the ninety-eight adult beetles reared from them, eighty-two were albinic, of a variety known as *pallida*. Two shewed characters of another albinic variety and fourteen were unmodified. The same insects were allowed to lay their subsequent batches of eggs under normal conditions, and all the offspring were unmodified.

MIGRATORY MOVEMENTS OF BIRDS.—Dr. C. J. Patten, who described his investigations upon the size of the testes with Sanderlings, claimed that he had found the key to some problems regarding the migratory movements of birds at the breeding season.

MITOKINETISM.—At a joint meeting with the Botanical Section, Professor Hartog demonstrated that in cell division the cell spindle is homopolar with respect to osmosis currents, electrolytic and electrostatic force, and as, therefore, magnetism is out of the question, he concluded that mitokinetism is a new force unknown so far outside the living cell.

ARTIFICIAL PARTHENOGENESIS.—The investigations described by Dr. Edward Hintle dealt with the cytological changes that follow the chemical fertilization of the eggs of sea urchins by means of a fatty monobasic acid, and the suggestion was made as their result that the known facts of artificial parthenogenesis might be competent to explain the origin of cancer.

SEX AND IMMUNITY.—The Parasite, *Sacculina*, causes its male host, the spider crab (*Inachus*) to assume adult female characters externally, and after the death of the parasite to produce ova from its testes. Young females are caused to assume adult female characters prematurely. Mr. Geoffrey Smith sought to show that this is an immunity phenomenon.

REVIEWS.

ASTRONOMY.

A Nautical Star Chart.—By CAPT. D. H. BERNARD. 33-in. × 19-in.

(Brown & Son, Glasgow: Price 1 6 net.)

This Chart, though primarily designed for the use of Naval Officers and at sea, is calculated to be exceedingly useful to all classes of Astronomers. It comprises, on Mercator's projection, all the stars between 70 of N. and 70 of S. Declination which appear in the *Nautical Almanac*; and therefore includes all the prominent and important naked-eye stars within the limits in question. The dimensions of the chart being 33-in. × 19-in., the scale is large and the stars are engraved large in size. The back of the chart is occupied with a varied amount of information, arranged in panels, such as brief remarks on the constellations, individual stars, and the planets; and various hints and suggestions relating to leading weather facts, the treatment of chronometers, nautical measurements, the use and misuse of the word "Knot," together with a Table of the Right Ascensions and Declinations of the one-hundred and thirty stars which are mapped. By the way, the epoch of this list is not given. Altogether we recommend this chart as one of wide general usefulness.

Popular Astronomy.—By S. Newcomb. 8-in. × 5¼-in. 579 pages. 112 illustrations and 5 maps.

(Macmillan & Co., Ltd. 8/6 net.)

The late Professor Newcomb's Treatise on Popular Astronomy is so well known and so highly appreciated that a reissue of it will be widely welcomed in England, but we are bound to enter a serious protest against the reprint now submitted to us having the date of 1910 on the title page, whilst no attempt has been made to edit the book and bring it up to that date. The "Publishers' Note" prefixed wholly fails to meet the case. It is suggested that the only changes the author would have made had he been still living "would have been in the nature of additions describing recent researches." We feel bound to traverse this statement. No author publishing a book in 1910 would have stated that "The last observed return of Encke's Comet was in 1881"; that Mr. A. A. Common (who died in 1903) possesses at Ealing the second largest Newtonian Reflector in England; that the younger Earl of Rosse (who died in 1908) is still carrying on his father's observations at Parsonstown; that the Minor Planets are two hundred and twenty in number, there now being between six hundred and seven hundred known. The List of Books "presented for the benefit of Teachers and Students" is hopelessly useless as well as out of date. Surely even a moderate amount of "editing" would have been reasonable and justifiable in view of the foregoing facts, even though the author had departed this life.

MEDICINE.

Physiology, the Servant of Medicine (Chloroform in the Laboratory and in the Hospital).—By A. D. Waller, M.D., LL.D., F.R.S. 5½-in. × 8½-in. 143 pages.

(Hodder & Stoughton. Price 5/-.)

The volume before us contains a series of lectures delivered at the University of California in 1909. In the preface its author describes it as consisting of "some fragments of Physiology, of which I have sought to emphasise the application to Practical Medicine, and among which the study of chloroform has been a constantly recurring note," and no one who reads the book will have any doubt as to its fragmentary character. In the earlier chapters the writer recapitulates his admirable work on the electrical currents which result from activity in practically all living tissues, both animal and vegetable, and shows how they are inhibited or abolished by the action of anaesthetics. In the last chapter the dangers of anaesthetics are discussed, the principal risk with chloroform being, in the author's opinion, the undue concentration of the vapour. He therefore suggests the use of the apparatus he has designed whereby the concentration of the vapour can be at once read off on a scale. The apparatus he uses is awkward and cumbersome, and although, perhaps, well suited for use in the laboratory, would not appear applicable to ordinary practice. In an appendix more experimental details are given, and the future of the University of London is discussed. The book is well supplied with diagrams and charts, and is written in clear lecture style. It gives an excellent resumé of Dr. Waller's physiological researches, but their direct application to the study of medicine is not in all cases clear.

The Death-dealing Insects and their Story.—By Conyers Morrell. 5-in. × 7¼-in. 79 pages.

(Manchester, H. A. W. Offices. Price 1/- net.)

This little book recites in popular language one of the most interesting chapters in recent medical research, and demonstrates the great assistance that has been obtained from biology in the study of tropical diseases in both man and the domestic animals. The author describes the life-history of the mosquitos, tse-tse flies and fleas, which are believed to be the sole agents by which such diseases as malaria (ague), yellow fever, sleeping sickness and plague are spread, and tells us something of how such diseases may be prevented by the destruction of these pests. Other less known affections, both of mankind and cattle, which are probably distributed in a similar manner, are also shortly described. The book is clearly and simply written, but unfortunately the illustrations are far from what they ought to be. Nevertheless, to those without medical knowledge, who are desirous of learning what has recently been done by the ordinary methods of scientific research for the prevention and cure of tropical diseases, the book is to be recommended.

METEOROLOGY.

Meteorology, Practical and Applied.—By Sir John Moore. 6-in. × 8¼-in. 492 pages.

(Messrs. Rebman, Ltd. Price 10/6 net.)

The first edition of this well-known book on Meteorology was published in 1894. Sir John Moore is a physician, and through many years he has found the study of Meteorology the needed foil to his more serious professional studies and pursuits, and his medical experience has enabled him to deal with the subject in a very special way. The book has for several years been out of print, and the rapid progress of meteorological science has rendered a thorough revision of it indispensable. Sir John Moore has done this very carefully, and considerable additions have been made. An important point is the number of new instruments which have been described and illustrated.

For the benefit of those who are not yet familiar with this standard work, we may say that it is divided into four parts. A brief introduction is followed by a full account of the methods which are employed in practical meteorology, the third part treats the climate and weather and with that of the British Isles in particular, while the remainder of the book has a practical bearing, and in it Sir John Moore combines his professional experience with his hobby, and gives a most valuable account of the influence of season and of weather on disease. We feel sure that the fascination which the subject of Meteorology has exerted over the author will cast its spell over those who read his "labour of love."

GENERAL.

Mona's Record of the Earth's Changes.—By Joseph Lewin. 5-in. × 7¼-in. 100 pages.

(Brown & Sons. Price 2/-.)

This little book contains some good photographs illustrating the scenery of the Isle of Man, and the letterpress deals with a number of interesting facts with regard to changes which have taken place in the habits of the people and in the conformation of the ground. For instance, at the time when a certain battle took place at Skye Hill the level of the sea, it is contended, must have been fifty feet higher than at present if it reached the foot of the hill.

NOTICES.

South-Western Polytechnic Institute, Chelsea.—Among the special evening classes which have been arranged in connection with the Biological Department are courses on Economic Zoölogy, Technical Botany, Gardening and Horticulture, as well as a well planned series of lectures on "Evolution," and practical demonstrations of Microscopy, Microtechnique, as well as Photo-micrography.

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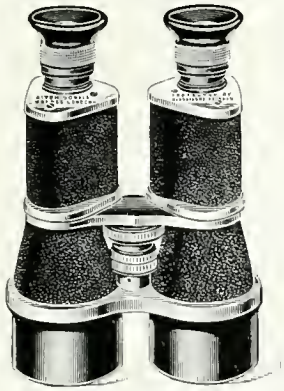

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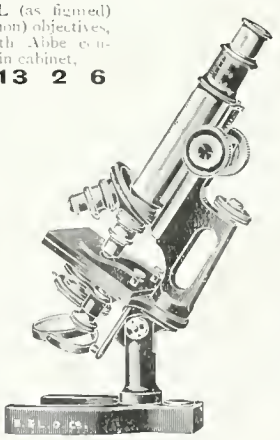

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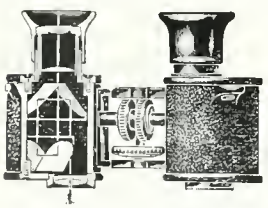

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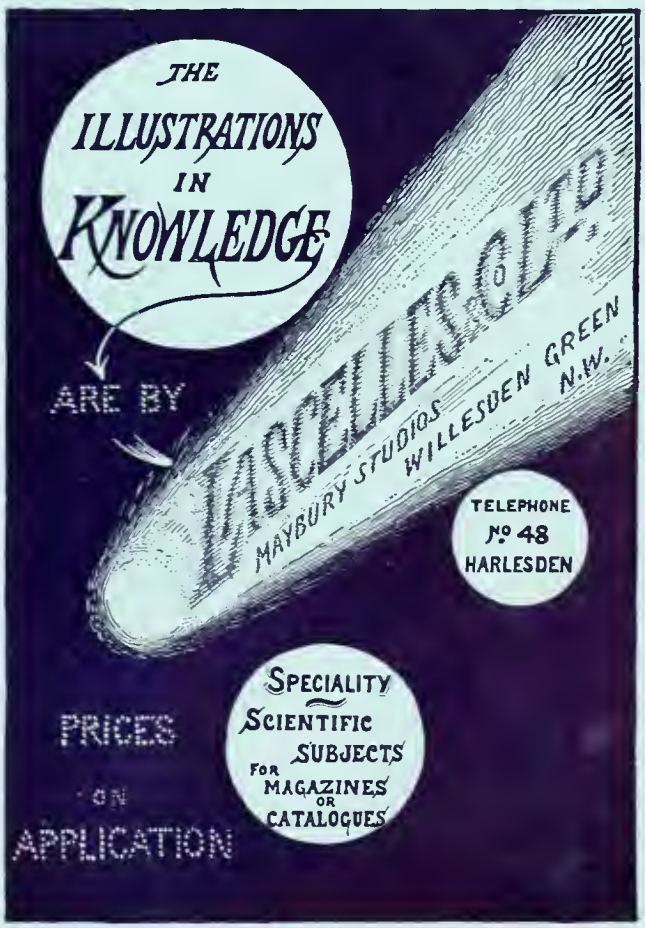

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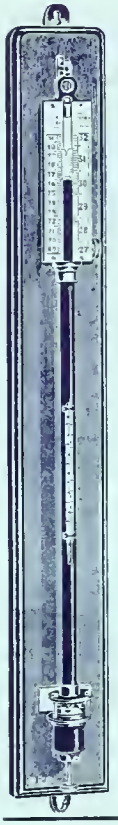

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